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June 18, 2021

Mr. Chan Pongkhamsing
EPA Remedial Project Manager
U.S. EPA Region 10
1200 Sixth Avenue, ECL 111
Seattle, WA 98101

RE: Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary

Dear Mr. Pongkhamsing:

Please find the enclosed copy of the *Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary*. Please let me know if you'd like a hard copy of the report mailed to you.

If you have any questions, please feel free to contact me by phone at 541.812.7230 or by email at Michael.Riley@ATImetals.com.

Sincerely,

Michael Riley

Manager, Environmental Operations & Compliance

Enclosures: 1. *Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary*

ATI Millersburg Operations

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary

June 18, 2021

Prepared by:
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Abbreviations and Acronyms

°C	degrees Celsius
µg/L	micrograms per liter
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethane
ATI	ATI Millersburg Operations Facility in Millersburg, Oregon
bgs	below ground surface
CA	chloroethane
cis-1,2-DCE	cis-1,2-dichloroethene
CVOC	chlorinated volatile organic compound
CWTS	Central Wastewater Treatment System
DEQ	Oregon Department of Environmental Quality
Dhb	*Dehalobacter*
Dhc	*Dehalococcoides*
DO	dissolved oxygen
EISB	enhanced in situ bioremediation
EPA	U.S. Environmental Protection Agency
FCCA	Former Crucible Cleaning Area
gpm	gallons per minute
GSI	GSI Water Solutions, Inc.
mg/L	milligrams per liter
mV	millivolts
Operations Plan	*Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Operations Plan, Revised*
ORP	oxidation reduction potential
OWRD	Oregon Water Resources Department
PCE	tetrachloroethene
psi	pounds per square inch
PVC	polyvinyl chloride

TCA	1,1,1-trichloroethane
TCE	trichloroethene
TOC	total organic carbon
UIC	underground injection control
VC	vinyl chloride

Section 1: Introduction

An initial enhanced in situ bioremediation (EISB) injection event was conducted in September 2010 at the Former Crucible Cleaning Area (FCCA), ATI Millersburg Operations Facility in Millersburg, Oregon (ATI; see Figure 1), in accordance with the June 2010 U.S. Environmental Protection Agency (EPA)-approved work plan (GSI, 2010). Also in accordance with the June 2010 work plan, a second EISB injection event was conducted in 2019 to address remaining dissolved phase chlorinated volatile organic compound (CVOC) concentrations present in groundwater. The following report provides details regarding the second phase of this remedial effort at the FCCA and summarizes results obtained to date.

1.1 Summary of 2010 Initial Injection Event

The initial EISB[1] injection event at the FCCA was conducted in September 2010. Two strings of temporary injection wells were installed. String 1 included 10 temporary injection points on 6-foot centers located on the southern end of the area, and String 2 included 6 temporary injection points on 10-foot centers located on the northern end of the FCCA (Figure 2). The injection fluids consisted of deoxygenated water buffered with 0.5 percent sodium bicarbonate and 5 percent Newman Zone substrate. Overall, approximately 24,199 gallons of substrate solution (22,990 gallons of water and 1,209 gallons of substrate) were injected into 16 temporary wells during an 8-day period. Because injections took place only during daylight hours, an additional 2,450 gallons of un-amended deoxygenated water were injected at various times to clean injection lines, dosing pumps, and well screens between injection cycles.

Microbes were injected approximately one third of the way through the injection cycle to ensure bacteria were successfully introduced into the subsurface before potential injection problems could occur. Each String 1 temporary well received 1 liter of KB-1 Plus® microbial inoculum distributed in two injections of 0.5 liter each for a total of 10 liters in String 1 wells. Each String 2 temporary well received 2 to 3.5 liters of KB-1 Plus® microbial inoculum for a total of 15.5 liters.

Groundwater monitoring was conducted in the source area (PW-93A), injection area (PW-100A, PW-94A, PW-69A, PW-95A, and PW-101A), and perimeter area (FW-1, PW-70AR). Groundwater monitoring was performed after injections were completed. Analyses included CVOC concentrations and field parameters during all sampling events. Results are detailed in the performance monitoring report issued in 2013 (GSI, 2013). In summary, the results showed that viable populations of dechlorinating bacteria were obtained and the groundwater field parameters were within the range of values required to promote reductive dechlorination. Significant reductions in CVOC concentrations were observed; based on these results, an optional third string of injection wells was not installed at that time. The second EISB phase was conducted in 2019 and is the subject of this report.

1.2 2019 Injection Event

Subsequent ongoing performance monitoring data collected each spring and fall through 2018 showed that concentrations of several chlorinated ethanes, including 1,1,1-trichloroethane (TCA), and chlorinated ethenes slowly increased in some wells over time and were detected above cleanup levels in monitoring wells PW-94, PW-95A, and PW-100A (GSI, 2019b). Additionally, oxidation reduction potential (ORP) levels had risen above optimal levels (i.e., greater than -75 millivolts) for reductive dechlorination of CVOCs in the FCCA hot spot monitoring wells (PW-93A, PW-94A, PW-95A, and PW-100A). Collectively, the performance

[1] For the work described in this report, the terms EISB, reductive dechlorination, and anaerobic biodegradation refer to processes by which specific anaerobic bacteria degrade CVOCs through a series of metabolic processes, typically with CVOCs serving as electron acceptors.

monitoring data showed that while EISB is effective at reductively dechlorinating CVOCs at the FCCA, the conditions supporting EISB were fading while concentrations of CVOCs remained.

In response to the performance monitoring data, highlighted in EPA's recommendation #2 of the *Fifth Five-Year Review* (EPA, 2017), ATI submitted an Operations Plan titled *Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Operations Plan, Revised,* dated August 16, 2019 (Operations Plan; GSI, 2019a). Following EPA approval, ATI completed a third string of injection wells within the FCCA in August 2019 (see Figure 2). The injections were intended to reestablish reducing conditions favorable for EISB and augment the viable populations of dechlorinating bacteria. The Operations Plan outlined the system design, system operation, and reporting activities for the project (GSI, 2019a).

1.3 Report Organization

Consistent with the reporting goals (Task 5) of the Operations Plan, this report provides a summary of the String 3 EISB project activities and performance monitoring data results collected from the FCCA monitoring wells through December 2020 (approximately 16 months following injection activities) as well as a review of the overall performance of the EISB remedial approach since it first began in 2010. This report contains the following sections:

- **Pre-Injection Field Work** – Consistent with Tasks 1 and 2 of the Operations Plan, this section describes planning and coordination activities, baseline sampling, and makeup water preparation carried out prior to temporary well installation and injection.
- **Injection Area Activities** – Consistent with Task 3 of the Operations Plan, this section describes construction and installation of the temporary wells and injection system, volumes of substrate solution and dechlorinating bacteria injected at each injection point, visual monitoring of the injected substrate solution, and well abandonment/demobilization activities.
- **Performance Monitoring Results** – Consistent with Task 4 of the Operations Plan, this section presents the post-injection performance monitoring results generated from samples collected during biannual performance monitoring events. This section also provides an overview of post-injection results across the entire remedial effort, including both the 2010 and 2019 injection events.
- **Conclusions –** This section provides an analysis of data trends within the FCCA monitoring wells from 2010 through 2020 following EISB injections.

Section 2: Pre-Injection Field Work

2.1 Project Planning and Coordination

Consistent with Task 1 of the Operations Plan, planning and coordination activities were carried out in preparation for the String 3 injections. The ATI project manager and GSI Water Solutions, Inc. (GSI), personnel scheduled all subcontractors, including the drillers, to ensure that planned injection activities would align with site operations. The ATI project manager coordinated communication among the ATI production staff, environmental personnel, and GSI field teams to ensure that injection operations and monitoring observations were completed safely. Project and site-specific Health and Safety Plans were updated, and all project personnel were confirmed to have all necessary site-specific health and safety training prior to working on site.

The site underground injection control (UIC) permit #13382 was updated with the Oregon Department of Environmental Quality (DEQ). Utility maps were reviewed by ATI engineering staff and utility locates were completed and marked in the project area to determine potential conflicts with the proposed well locations. Stormwater facilities elevations, maps, and locations were examined to anticipate the location of potential injection migration pathways, including checking for groundwater infiltration in the furnace pit of the Arc Melting Building.

Field equipment and materials, including the makeup water tank, were ordered and delivered to the site. GSI field staff worked with ATI to site the makeup water tank and other large equipment within the FCCA project area so as not to impede facility operations.

2.2 Makeup Water Preparation

The deoxygenated makeup water required for substrate and microbe injections in the FCCA was produced in one 21,000-gallon bi-level, closed steel tank rented from Rain for Rent in Portland, Oregon. The tank was sited by ATI personnel and GSI field staff on July 30, 2019, in a roadway southeast of the injection area and Building S-186 (see Figure 2). The tank was cleaned by Rain for Rent before and after use. Beginning on August 1, 2019, groundwater was pumped from extraction well FW-1 on the southeast perimeter of the FCCA until the tank was filled approximately one week later. Using groundwater pumped adjacent to the FCCA instead of an industrial water source was thought to better acclimate dechlorinating bacteria to native groundwater conditions while also lowering the groundwater table as a buffer against groundwater mounding during injections.

The KB-1 Plus® microbial inoculum requires anaerobic conditions to survive, so it was necessary to deoxygenate the makeup water prior to its use for injections. To accomplish this, approximately 5 gallons of technical-grade 60 percent sodium lactate (at a concentration of approximately 150 parts per million) was added to the tank during filling to promote the biological activity necessary to deoxygenate the makeup water. A recirculation pump was used within the tank to thoroughly mix the sodium lactate throughout the makeup water. A YSI multi-parameter probe was used to monitor dissolved oxygen (DO) and ORP until target concentrations were achieved (i.e., <0.2 milligrams/liter [mg/L] and <-75 millivolts [mV], respectively). After target levels of DO and ORP were achieved, argon gas was used to blanket the top of the water surface to slow any re-oxygenation prior to injections.

The enhanced anaerobic bioremediation process produces acidity and typically will lower groundwater pH, which can reduce the effectiveness/viability of the bacteria. Therefore, amendments were added to the makeup water to buffer the pH of the substrate solution during injection and to keep groundwater pH at optimal levels for the dechlorinating microbes. Approximately 1,000 pounds of food-grade sodium

bicarbonate was added directly to the tank during filling to produce a target sodium bicarbonate concentration of approximately 0.5 percent. At 0.5 percent concentration, the sodium bicarbonate dissolved completely and no clogging problems were encountered with the injection equipment or in the temporary wells during the injection cycles.

A water sample for chemical analysis of CVOCs was collected from the tank on August 15, 2019, and submitted to APEX Laboratories in Tigard, Oregon. Analytical results are discussed in the baseline sampling section below. A YSI multi-parameter water quality instrument was used to monitor the parameters of temperature, pH, DO, and ORP in the makeup water and to track the deoxygenation process. The parameter readings taken from the tank on August 23, 2019, (before initiating injections) were 22.6 degrees Celsius (° C) for temperature, 7.80 for pH, 0.04 mg/L for DO, and -175.8 mV for ORP, all of which met target requirements for proliferating dechlorinating bacteria.

2.3 Baseline Sampling

Consistent with Task 2 of the Operations Plan, groundwater samples and a makeup water sample were collected prior to injection activities to establish baseline water quality conditions. Specifically, the baseline sampling program included:

- Groundwater samples and water quality parameters collected during the spring 2019 biannual monitoring event at FCCA wells PW-69A, PW-93A, PW-94A, PW-95A, PW-100A, and PW-101A.
- A groundwater sample collected from extraction well FW-1 (makeup water source) and a makeup water sample collected from the tank in August 2019, both of which were analyzed for the full suite of VOCs. Makeup water was also continually monitored for field parameters to ensure that the injected substrate solution was ideal for EISB.

2.3.1 Groundwater

Baseline groundwater monitoring samples were collected from FCCA monitoring wells in May 2019 as part of the spring 2019 biannual monitoring event. Consistent with the 2010 work plan, FCCA wells were designated as being in the following areas:

- Source Area Well: PW-93A
- Injection Area Wells: PW-100A and PW-94A
- Near Injection Area Wells: PW-69A, PW-95A, and PW-101A
- Perimeter Area Well: FW-1

As outlined in the Operations Plan, groundwater samples were analyzed for water quality field parameters, including DO, ORP, pH, temperature, and specific conductance; CVOCs; dissolved hydrocarbon gases, including methane, ethane, and ethene; total organic carbon (TOC); and general chemistry parameters, including alkalinity, nitrate, chloride, and sulfate. The groundwater samples were collected using a peristaltic pump operated at a low-flow purge rate of approximately 0.15 gallons per minute (gpm) or less. Where feasible, the procedures and criteria for EPA low-flow sampling of groundwater were used to collect the samples.

Baseline sampling results from May 2019 are shown in Table 1 and in Appendix A. Concentrations of CVOCs exceeding established cleanup levels included the following:

- TCA (748 microgram per liter [µg/L]), 1,1-dichloroethene (1,1-DCE) (57.8 µg/L), and vinyl chloride (VC) (4.6 µg/L) in PW-94A

- Tetrachloroethene (PCE) (5.95 µg/L), 1,1-DCE (9.95 µg/L), and VC (2.2 µg/L) in PW-69A
- TCA (805 µg/L) and 1,1-DCE (68.2 µg/L) in PW-95A
- TCA (511 µg/L), 1,1-DCE (110 µg/L), and VC (9.23 µg/L) in FW-1

The highest concentration for VC was detected in well PW-100A (23.8 µg/L), just north of well PW-93A. Complete analytical details of the baseline sampling are presented in Table 1.

2.3.2 Makeup Water

A sample was collected from the makeup water tank on August 15, 2019, to document water quality conditions before injections. Concentrations of chlorinated ethanes (TCA, 1,1-dichloroethane [1,1-DCA], and chloroethane [CA]) and chlorinated ethenes (PCE, trichloroethene [TCE], 1,1-DCE, cis-1,2-dichloroethene [cis-1,2-DCE], and VC) were detected within the makeup water. CVOC results from the makeup water sample are included in Appendix B. The makeup water was recirculated in the tank and allowed to sit for approximately 3 weeks prior to injection to allow for sufficient deoxygenation.

Section 3: Injection Area Activities

As stated above, makeup water was recirculated in the tank and allowed to sit for approximately 3 weeks (August 1–23, 2019) prior to injection to allow for sufficient deoxygenation. Construction activities took place at the end of this period to locate and install the string of temporary injection wells (String 3), complete the distribution system plumbing to transfer water from the makeup water tank to the injection area, and complete injection manifolds and valving to deliver substrate solution and KB-1 Plus® microbial inoculum to the temporary injection points. Upon completion of the well installation and plumbing for the distribution system, injections of deoxygenated, buffered water with Newman Zone substrate and KB-1 Plus® dechlorinating bacteria were conducted August 23–25, 2019. Groundwater level monitoring and substrate solution distribution monitoring were performed to evaluate injection performance, assess subsurface hydraulic response, and ensure that injected substrate solution was not infiltrating adjacent utilities during the injections. Each of these activities is discussed in greater detail in the following sections.

3.1 Temporary Well Design and Installation

The Operations Plan anticipated that 8 to 10 temporary wells would be installed on approximately 10-foot centers. Utility maps were reviewed and a utility locate was conducted to determine whether proposed well locations conflicted with identified subsurface utilities. On August 22, 2019, the drilling contractor began coring through the 18- to 24-inch-thick reinforced concrete present at the proposed well locations. Cored locations were then hand-augured and/or cleared with a vac truck to 5 feet below ground surface (bgs) to ensure that utilities were not present at each location. Waste soils were placed in drums and labeled as hazardous waste prior to disposal by ATI.

A shallow freshwater cooling line was nicked during the initial concrete coring of temporary injection well #2 in the vicinity of CB-047 and required additional concrete removal to provide access for repairs. Non-energized electrical wires were discovered by the drilling crew as they cleared temporary injection well #9 with the vac truck. As a result, a new location for temporary injection well #9 was chosen slightly east of the original proposed location. No other utilities were observed or impacted during the installation of the temporary injection wells. Once all proposed locations had been cleared to 5 feet bgs, temporary injection wells were installed with a GeoProbe direct push rig. The locations for all 10 temporary injection wells are shown in Figure 2.

The vertical target injection area for the project was defined as the saturated zone of the Linn Gravel. The thickness of the Linn Gravel previously logged at the site was generally between 11 to 15 feet thick and is encountered approximately 10 to 14 feet bgs. The gravels are interbedded with silt and sandy-silt layers at some locations. GeoProbe rods were advanced approximately 25 feet bgs before installing temporary injection wells with the following specifications (see Figure 3):

- 1-inch polyvinyl chloride (PVC) well casings with 20 slot screens, 15 feet in length
- 18-inch bentonite collars placed at the top of the well screen during installation
- 5 feet of granular bentonite annular seal above the collars
- Concrete surface seal with approximately 2 feet of stick-up to allow sealing surface for aboveground wellhead fittings

Ten temporary injection wells were completed from August 22–23, 2019, prior to injection activities.

3.2 Injection System Construction

As depicted in Figure 2, the makeup water tank was sited approximately 60 to 100 feet southeast of the temporary injection wells near extraction well FW-1. Tank drains and hoses were fit to the bottom of the tank to minimize the opportunity for re-oxygenation of the makeup water. A 110-volt transfer pump was positioned at the makeup water tank outlet to provide consistent flow and pressure of deoxygenated water to a pre-injection manifold. The pre-injection manifold was composed of clear 1-inch PVC to allow for the inspection and elimination of any entrained air. An air relief valve positioned at the high point in the manifold allowed gases to be released while a pressure gauge provided a quick check of pump performance and water delivery pressure to the injection manifold. Fine pressure control was achieved by valves and a return line that led back to the bottom of the makeup water tank. Primary flow control was achieved through a solid flow control orifice located at the pump discharge port to keep system-wide pressures at or below 20 pounds per square inch (psi). Flows from the pre-injection manifold passed directly to a 10-channel modular injection system, or injection manifold, assembled by Remediation and Natural Attenuation Services, Inc. The injection manifold consisted of the following components:

- A universal pipe adaptor.
- Parallel dosing pumps capable of delivering 5 percent concentrations of Newman Zone.
- Two siphon lines to four Newman Zone totes (see Figure 2).
- Two mixing and collection manifolds.
- 10 mechanical flow meters to accurately measure and distribute the substrate solution to each of the 10 temporary injection wells.
- Clear 0.75-inch-inside-diameter braided polyethylene tubing leading to each of the temporary injection wells.
- Wellhead fittings with oil-filled pressure gauges, air-relief and injection valves, flow control valves, and digital flow meters. Wellhead fittings were made of clear food-grade PVC to allow inspection of injection fluids for color, mixing, and bubble-free flow.

3.3 Substrate Solution and KB-1 Plus® Injections

Injections of substrate solution and microbes were completed consistent with protocols outlined in the Operations Plan. Injections in the source area occurred between August 23–25, 2019, following completion of the injection system assembly and temporary well construction. As previously discussed, all makeup water quality parameters were monitored prior to injections to ensure that the injected substrate solution would meet the requirements to proliferate the dechlorinating bacteria, *Dehalococcoides* (Dhc) and *Dehalobacter* (Dhb), present in the KB-1 Plus® microbial inoculum, which was purchased from SiREM Laboratory in Guelph, Ontario, Canada. The injection fluids consisted of deoxygenated water buffered with approximately 0.5 percent sodium bicarbonate and 5 percent Newman Zone oil substrate to serve as an electron donor for the dechlorinating bacteria. The sodium bicarbonate buffer was added directly to the makeup tanks during filling and the Newman Zone was added with parallel dosing pumps connected to the injection manifold. A goal of the injections was to distribute the substrate solution and dechlorinating bacteria equally throughout the impacted FCCA groundwater without affecting the nearby Arc Melting Building furnace pit to the north or mobilizing contaminants from the area. To these ends, injection rates and injection pressures were kept below 1.5 gpm and 5 psi, respectively, to reduce hydraulic mounding and/or subsurface fracturing that could lead to the development of preferential pathways or infiltration of adjacent utilities.

Injections of KB-1 Plus® microbial inoculum were completed at each well on the morning of August 24, 2019, approximately halfway through the injection cycle. DEQ personnel were on site to oversee the

injections. The timing of the addition of the dechlorinating bacteria was consistent with previous recommendations from EPA and SiREM to ensure bacteria were injected successfully into the subsurface before potential injection problems occurred. All injection steps outlined in the Operations Plan were followed to complete the microbe injections. Specifically, microbe injections were performed by personnel trained by SiREM to perform these injections, and included the following steps:

- Confirming with SiREM that conditions were suitable for injections.
- Purging delivery tubing with argon gas before releasing bacteria from the storage vessel.
- Using the gas valve to bleed any air in the injection well tubing.
- Exercising care to eliminate exposure of bacteria to air.
- Using a digital scale at the well to deliver an equal fraction (2 kilograms or 2 liters) of KB-1 Plus® microbial inoculum halfway through the injection interval at each temporary injection well.
- Recording all injections in the field logbook.

Table 2 and Figure 4 detail the volumes of substrate solution and KB-1 Plus® microbial inoculum injected in each of the temporary wells from August 23–25, 2019. In total, approximately 21,731 gallons[2] of substrate solution were injected into 10 temporary wells during a 32-hour period. Because of an Oregon Water Resources Department (OWRD) requirement to remove the temporary injection wells within 72 hours after installation, injections were run continuously until all the substrate solution had been injected. GSI field personnel took shifts to ensure that all wells and equipment were monitored throughout the duration of the injection. The 21,731 gallons injected over 32 hours amongst 10 temporary injection wells equates to an injection rate of approximately 1.13 gpm per well, which met the objective of keeping injection rates below 1.5 gpm at each well.

3.4 Hydraulic and Substrate Solution Distribution Monitoring

All nearby monitoring wells were monitored for hydraulic response and substrate solution breakthrough just prior to and throughout the injections in accordance with the Operations Plan. Additionally, shallow utility corridors, catch basins, and the Arc Melting Building sump were visually inspected throughout the injection for potential breakthrough of substrate solution. Summaries of measured water levels and visual monitoring observations over the course of the active injection are included in Appendix B.

All monitoring wells showed a hydraulic response during the injections with the most significant response occurring at PW-93A; water levels within the well rose approximately 9 feet to the ground surface shortly after injections began. Groundwater levels increased from approximately 2.75 feet to 8 feet in other FCCA wells, with those nearest the injection points typically showing the greatest hydraulic response. Over the course of the injections, no groundwater was observed entering any of the facility's chemical or stormwater drains. Approximately 10 hours after injections were completed, groundwater levels returned to within 1-foot of pre-injection measurements in all FCCA monitoring wells.

Consistent with the Operations Plan, dedicated bailers were used at all monitoring wells to assess for the presence of injected substrate solution; Newman Zone produces a milky white color in groundwater even at small concentrations and can be easily detected. One hour after injections began, substrate solution was detected in PW-93A, PW-100A, and PW-101A. Approximately 9 hours after injections began, substrate

[2] Total substrate solution injection volumes presented in Table 2 were calculated from the mechanical flow meters on the injection manifold rather than the digital flow meters on each wellhead fitting, as they were deemed to be more accurate. The total volume calculated from the digital meters was 19,275 gallons. Flow volumes for both sets of flow meters are presented in the field notes in Attachment A.

solution was observed at PW-69A. Substrate solution was then observed at PW-94A and PW-95A approximately 11 and 13 hours after beginning injections, respectively. Substrate solution observed at PW-94A was only present within the bottom 3 feet of the well, indicating some heterogeneity, preferential pathways, and/or hydraulic obstructions within higher (shallower) portions of the adjacent aquifer. In summary, substrate solution was observed in all FCCA monitoring wells within 13 hours of injections, indicating successful dispersal of substrate solution throughout the target treatment area. In addition to being observed in the monitoring wells, substrate solution daylighted through a crack in the pavement near PW-93A. When this was observed, the flow rate was reduced and the concrete was washed down with water, which entered the Central Wastewater Treatment System (CWTS) where the wash water was held and treated prior to discharge. The substrate solution also daylighted through a seam in the concrete blast wall of the Arc Melting Building, where it collected in the furnace sump. GSI field personnel estimated the initial rate of seepage into the Arc Melting Building at approximately 0.25 gpm. Attempts were made to seal off the leak into the Arc Melting Building with a hole plug, and flow to temporary injection well #5 (nearest the Arc Melting Building) was reduced. These actions reduced the flow of substrate solution into the Arc Melting Building but did not eliminate all seepage. The Arc Melting Building furnace sump has a pump to forward process water to the wastewater treatment system. Operations staff from CWTS observed white discharge to the CWTS resulting from the substrate solution that had been pumped from the Arc Melting Building sump. GSI personnel reviewed the Newman Zone Safety Data Sheet with the CWTS staff, and it was determined that the ecotoxicity of the substrate was low, the quantity of substrate was negligible, and the substrate discharge to the CWTS would not result in a permit limit exceedance. The flow through injection well #5 was turned off and field staff continued to monitor the seepage.

No substrate solution was observed at extraction well FW-1 or in any of the catch basins monitored within the FCCA over the course of the injection. Well FW-1 was continuously operated during the injection to provide hydraulic containment in the FCCA and allow makeup water and substrate to be pulled across the area of contamination. The extraction well was shut down at the end of the injection event so that groundwater containing substrate solution would not inadvertently be extracted.

3.5 Injection Performance Summary

Preparation activities, injections, and demobilization activities followed the schedule and procedures outlined in the Operations Plan. Aside from navigating unknown utilities during well installation and the observed seepage into the Arc Melting Building during injections, no performance difficulties were encountered during preparation, construction, or implementation activities. Anticipated volumes of substrate solution and KB-1 Plus® microbial inoculum were distributed through the temporary injection wells, and visual monitoring in FCCA monitoring wells confirmed that the substrate solution was widely distributed. The observed seepage into the Arc Melting Building was contained by a sump pump discharging to the facility's wastewater treatment system and did not require delays or a shutdown. Following completion of injection activities, temporary wells were abandoned within the 72-hour OWRD regulatory window, and all equipment was cleaned and taken offsite. Documentation of preparation, construction, and injection activities were recorded in field books and construction logs.

The injection system performed satisfactorily with no down time or delays recorded for equipment failures. The sodium bicarbonate and Newman Zone amendments did not clog injection equipment or well screens. No increases in injection pressures over time were recorded that would suggest clogging in the soil formations present in the treatment area.

Section 4: Performance Monitoring Results

Performance monitoring results for TCA, TCE, and associated daughter products[3,4] at each FCCA monitoring well are discussed in the following sections. These results are discussed relative to the Operable Unit 2 Record of Decision[5] cleanup levels at each well during the respective 13-month and 16-month monitoring periods.[6] Additional chemical parameters pertinent to assessing reductive dechlorination, such as methane and chloride, are also discussed.

Following injections, performance monitoring data were collected from the same wells used to assess baseline groundwater conditions. Consistent with the Operations Plan, performance monitoring samples were collected at 2 months (October 2019), 8 months (April 2020), 11 months (July 2020 for PW-94A and FW-1), 13 months (September 2020), and 16 months (December 2020 for PW-93A, PW-94A, and FW-1) as part of sitewide performance monitoring events, with the exception of the events in July and December 2020, which were related to other remedial activities occurring at the site. Analyses included CVOC concentrations and field parameters during all sampling events. Concentrations of dechlorinating bacteria (Dhc/Dhb) were evaluated at 2 months (October 2019) and at 16 months (December 2020) in well PW-93A to assess whether the target bacteria were proliferating in the course of reductive dechlorination of CVOCs. The performance monitoring results are discussed below.

4.1 Field Parameters and Total Organic Carbon

4.1.1 Field Parameters

Field parameters were collected from each of the FCCA monitoring wells during performance monitoring events, and some of the data were used to evaluate if conditions were favorable for reductive dechlorination. The field parameters included pH, specific conductance, temperature, DO, and ORP. The field parameters were recorded while purging the wells prior to collection of laboratory samples. Where feasible, the procedures and criteria for EPA low-flow sampling of groundwater were used to collect the field parameters, including use of a peristaltic pump operated at a low-flow purge rate of approximately 0.15 gpm or less. Values were recorded using a YSI multi-parameter meter after achieving stable values for each groundwater parameter. The instrument was calibrated daily using fresh calibration standards, and measurements were compared to values from previous events to identify and avoid errors.

Field parameter values recorded at each well during the various sampling events over the 16-month performance monitoring period are included in Table 1 and Appendix B. Optimal groundwater parameters, as recommended by EPA in its guidance for assessing natural biological attenuation of chlorinated solvents (EPA, 1998), are included along with similar recommended groundwater parameter values provided by SiREM laboratory for proliferation of Dhc/Dhb bacteria in the KB-1 Plus® microbial inoculum.

[3] Daughter products refers to the degradation products of more chlorinated compounds; for example, 1,1-DCA is a daughter product of 1,1,1-TCA and cis-1,2-DCE is a daughter product of TCE, which in turn is a daughter product of PCE.

[4] Laboratory reports showing CVOC concentrations and TOC are stored in the project file on the GSI server and are available upon request.

[5] Record of Decision Declaration, Decision Summary, and Responsiveness Summary for Final Remedial Action of Groundwater and Sediments Operable Unit, Teledyne Wah Chang Albany Superfund Site, Millersburg, Oregon (EPA, 1994).

[6] Additional performance monitoring samples were collected from wells PW-93A, PW-94A, and FW-1 in December 2020, 16 months after the August 2019 injections. The remaining FCCA wells were last sampled in September 2020, 13 months after the injections.

Groundwater field parameters in the FCCA are generally within the range of values recognized by both EPA and SiREM to promote reductive dechlorination. The pH values at all FCCA monitoring wells ranged from 5.87 to 7.19 over the 16-month performance monitoring period, well within the optimal range for EISB of CVOCs. Only one pH value was recorded below a pH of 6, and pH levels remained within ±0.54 pH units of pre-injection baseline levels at all wells.

Immediately following the injections, DO concentrations dropped in all FCCA monitoring wells to concentrations below 0.2 mg/L, achieving the optimal conditions outlined by both EPA and SiREM to promote reductive dechlorination of CVOCs. During the 16-month performance monitoring period, DO concentrations remained below the EPA recommended maximum DO concentration of 0.5 mg/L (EPA, 1998), but have slowly increased in all FCCA monitoring wells from concentrations observed just after injection activities (Figure 5).

ORP values similarly decreased in FCCA monitoring wells following injections, reaching values conducive to reductive dechlorination (Figure 5). The most recent data recorded at PW-93A, PW-94A, PW-100A, and PW-69A show optimal ORP values less than -75 mV. The most recent ORP data collected from PW-95A (4.6 mV) and PW-101A (-62.9 mV) are above optimal values recommended by EPA (<-100 mV) and SiREM (<-75 mV), but still within a range where reductive dechlorination is possible (EPA, 1998).

Overall, ORP and DO have remained generally conducive to microbial reductive dechlorination in the FCCA throughout the 2010–2020 injection and monitoring period. The pH has also varied little since the baseline 2010 and 2019 monitoring events. ORP and DO in source and injection area wells were largely within the EPA-recommended ranges of <50 mV and <0.5 mg/L for ORP and DO, respectively (see Figure 5 and Appendix B), and several recent ORP results have fallen within EPA's "likely" range for reductive dechlorination of <-100 mV. This indicates that conditions have been generally favorable for dechlorination throughout the ten-year length of the injection and monitoring period.

4.1.2 Total Organic Carbon

TOC concentrations in all wells are shown spatially in Figure 6. In the year following the 2010 injection, TOC concentrations rose significantly in source area well PW-93A, but TOC had again decreased to pre-injection levels after five years. The 2019 injection and addition of TOC added the necessary substrate to promote bacterial growth and reinvigorate the dechlorination process.

Shortly after the 2019 injection activities, TOC values were shown to have increased in source and injection area wells (PW-93A, PW-94A, and PW-100A) to concentrations ranging from 82 mg/L to 461 mg/L. TOC values in these wells have slowly decreased over the 16-month performance monitoring period to concentrations ranging from 5.13 mg/L to 42.7 mg/L. TOC concentrations decreased from 82.2 mg/L to 6.67 mg/L between the 2-month and 8-month samples collected at PW-94A. Although Newman Zone substrate was observed in all FCCA monitoring wells during injections, TOC concentrations were notably lower in post-injection samples collected from wells further from the injection area, likely due to the lower mobility of the Newman Zone substrate. TOC was detected in wells PW-95A and PW-69A at concentrations of 4.17 mg/L and 14.5 mg/L, respectively, 2 months after injections. Most recently, TOC was detected in wells PW-95A and PW-69A at concentrations of 1.7 mg/L and 4.22 mg/L, respectively. The TOC is below the value EPA identifies in its monitored natural attenuation guidance as optimal for anaerobic biodegradation of CVOCs (EPA, 1998). However, that criterion is inappropriate for emulsified vegetable oil substrates, such as Newman Zone, which absorb into aquifer matrix and release slowly.

4.2 Dechlorinating Bacteria

Concentrations of dechlorinating bacteria, Dhc and Dhb (present within the KB-1 Plus® microbial inoculum), were evaluated at source area monitoring well PW-93A, approximately 2 months (October 2019) and 16 months (December 2020) after the injections. The microbial analysis was performed by SiREM using its proprietary analytical method, Gene-Trac®. Chlorinated ethene-degrading bacteria (Dhc) increased by two times (1×10^6 to 2×10^6) during the performance monitoring period (measured in gene copies/liter). Concentrations of the chlorinated ethene and ethane-degrading bacteria (Dhb) increased by more than seven times (4×10^6 to 3×10^7). Concentrations and increases in both Dhc and Dhb populations are indicative of populations thriving as they degrade chlorinated ethenes, TCA, and 1,1-DCA.

4.3 Methane and Chloride

Methane concentrations increased in most performance monitoring wells following the 2019 substrate injection (Table 1). Monitoring wells PW-94A, PW-69A, and PW-95A have shown increases in methane concentrations of approximately 3, 3.5, and 6 times the baseline concentrations from May 2019, respectively. The presence of methane indicates fermentation is occurring in an anaerobic environment conducive to bacteria growth and reductive dechlorination processes.

Chloride concentrations are shown in Table 1. Chloride concentrations typically increase in groundwater as reductive dechlorination of TCA and TCE occur. The chloride performance monitoring results show modest increases in source area well PW-93A and injection area well PW-100A during the monitoring period. PW-93A was observed to have an initial large increase in chloride at 2 months and 8 months, but the chloride concentration then decreased during the subsequent monitoring events. Chloride concentrations were relatively stable in the rest of the wells.

4.4 CVOC Results

Although trends in CVOC data at individual monitoring wells are useful to understanding the viability of the EISB remedy, individual monitoring wells do not represent closed systems or batch conditions. To address this, CVOC data trends across both injection events were evaluated. The EISB performance is summarized in Figures 7, 8, 9, and 10, which provide the distribution of the various CVOCs over time and shrinkage of the plume as a result of the remedial activities.

4.4.1 Ethanes

At the 2010 baseline monitoring, the TCA plume reached concentrations of greater than 10,000 µg/L (11,100 µg/L at PE-93A) and encompassed much of the FCCA (Figure 8). The plume consisted of two separate areas with elevated TCA concentrations centered on PW-93A and FW-1. The 1,1-DCA plume (Figure 9) appeared similar to the TCA plume, with two areas with 1,1-DCA concentrations elevated relative to the rest of the plume centered on PW-93A and FW-1. At the same time, the CA plume was rather small, approximately 80 feet in diameter at the widest point (Figure 10), with CA concentrations all below 300 µg/L. TOC concentrations were low prior to the first injection, below 15 mg/L in all wells (Figure 6), and ORP and DO were within EPA's accepted ranges for microbially mediated reductive dechlorination.

Following the first injection, TCA concentrations dropped to the 2019 baseline levels shown in Figure 8. The most highly concentrated section of the plume migrated south (following the groundwater gradient) and significantly shrunk in size. At the 2019 baseline sampling, the footprint of the 1,1-DCA plume had increased in size since 2010, but 1,1-DCA concentrations had generally decreased from 2010 baseline levels (Figure 7 and 9). Due to the nature of reductive dechlorination of TCA, increases in 1,1-DCA concentrations are expected to coincide with decreases in TCA, while increases in CA concentrations are expected to coincide

with dechlorination of 1,1-DCA. Immediately following the injection, CA concentrations increased in all wells except PW-95A (Table 1), and at the time of the 2019 baseline monitoring, the CA plume had increased in size (Figure 10). These downward 1,1-DCA concentration trends represent the conversion of 1,1-DCA to CA while overall TCA concentrations decreased. In addition, 1,1-DCA concentrations may remain relatively constant or fluctuate up and down in wells where biological reductive dechlorination of TCA continues to counterbalance the dechlorination of 1,1-DCA to CA.

Following the fall 2019 EISB injection, the TCA plume shrank in size dramatically (Figure 8) and concentrations once again dropped appreciably. The 1,1-DCA plume did not significantly change in size, but the most concentrated portion of the plume shifted from the south of the FCCA back to the source area. This suggests a similar trend in concentration to that seen at PW-93A following the first injection and suggests that 1,1-DCA generation accelerated in the source area following the 2019 injection. The CA plume did not increase in size, but CA concentrations generally increased in the source area following the 2019 injection.

4.4.2 Ethenes

Although a relatively minor portion of the overall CVOC plume at the site, PCE, TCE, 1,1-DCE, and VC concentrations from 2010 to 2020 are presented spatially in Figure 7. Extended ethene results can be found in Appendix A. Concentrations of CVOCs in monitoring wells PW-100A, PW-93A, and PW-69A all exceeded the PCE/TCE CULs of 5 µg/L at the time of the 2010 baseline sampling. At the 2019 baseline monitoring, PCE and TCE concentrations were all below the CUL, with the exception of PW-69A, which was slightly above the CUL at 5.95 µg/L PCE. Detected PCE/TCE concentrations remained relatively unaffected throughout the subsequent monitoring period. These low baseline concentrations may not have been high enough to promote reductive dechlorination of ethenes. Significant increases in cis-1,2-DCE, the daughter product of PCE/TCE, were not observed in most of the FCCA wells following the first injection, and concentrations generally decreased or remained stable following the 2019 injection. Similarly, VC concentrations generally decreased or remained stable following the 2010 and 2019 injections. As of the last monitoring event in 2020, VC still exceeds the CUL in all wells except PW-101A.

The desired decrease in concentrations of PCE/TCE and associated increase in cis-1,2-DCE and VC concentrations in daughter products is not strongly evident from the 2010 through 2020 results, likely due to the low concentrations of chlorinated ethenes compared with those of chlorinated ethanes. Nonetheless, the decreases in PCE/TCE concentrations following the first injection and the increase in Dhc bacteria concentrations following the 2019 injection suggest evidence of reductive dechlorination, particularly around the original source area. These trends suggest that EISB of chlorinated ethenes has occurred within the FCCA since the first injection in 2010. Continued CVOC monitoring will confirm the effectiveness of chlorinated ethene degradation at FCCA wells.

Section 5: Conclusions

Based on implementation and the performance monitoring results since 2010, the following conclusions were reached:

- The distribution and overall concentrations of the CVOCs present in the FCCA have been reduced substantially over the last ten years. The plume is shrinking as a result of the EISB injection events and overall success of the remedial effort. Concentrations of TCA have been reduced in the FCCA from 11,100 µg/L at well PW-93A (pre-2019 injection) to a high of 353 µg/L at well PW-69A (post-2019 injection). This a reduction of nearly three orders of magnitude. Concentrations have been reduced and the overall horizontal distribution of the plume has decreased as well.
- The initial 2010 injection produced TOC concentrations that were high enough to support CVOC degradation; however, the additional TOC added during the 2019 injection was necessary to the continuation of the degradation process. Following injections, TOC concentrations increased in the source and injection area wells to concentrations well above concentrations EPA identifies as being optimal for anaerobic biodegradation of CVOCs. Although Newman Zone substrate was observed in all FCCA monitoring wells during injections, TOC concentrations were notably lower in post-injection samples collected from wells farther from the injection area; this was likely due to the low mobility of the Newman Zone substrate. TOC concentrations have decreased in source and injection area wells as TOC is consumed by the dechlorinating bacteria. This also occurred following the 2010 injection, where TOC levels decreased to baseline levels several years after the injection. TOC concentrations higher than 20 mg/L still persist in some FCCA wells.
- Performance monitoring for dechlorinating bacteria at 2 months and 16 months post-injection revealed viable populations of Dhb and Dhc in source area well PW-93A. Dhb populations had increased by more than seven times from the 2-month to 16-month period, while Dhc populations had doubled over the same timeframe. These results indicate that reductive dechlorination of both chlorinated ethanes and ethenes is occurring within the FCCA.
- At 16 months after the 2019 injection and the associated reductive dechlorination, TCA concentrations were below the cleanup level in four of seven project area wells, and decreases in TCA concentrations have occurred in all wells but PW-69A. No other chlorinated ethanes were detected above cleanup levels. The chlorinated ethane analytical data and the increases in Dhb bacterial populations suggest that reductive dechlorination of chlorinated ethanes continues throughout the FCCA, and has been occurring at variable rates since the first injection in 2010.
- TCE concentrations are currently below the cleanup level in all project wells. DCE concentrations remain above the cleanup level in four wells and VC concentrations remain above cleanup levels in six wells, but concentrations trends along with increases in ethene and Dhc bacteria suggest that reductive dechlorination of ethenes continues in select FCCA wells. Continued CVOC monitoring will confirm the effectiveness of chlorinated ethene degradation at FCCA wells.

Section 6: References

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Tables

Table 1. FCCA String 3 EISB Performance Monitoring Analytical Results

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Parameter	Units	Cleanup Standard	Source Area Well PW-93A						Injection Area Well PW-100A				
			Baseline 5/10	Inj #2 Baseline 5/19	10/19	4/20	9/20	12/20	Baseline 8/10	Inj #2 Baseline 5/19	10/19	4/20	9/20
CVOCs													
1,1,1- TCA	µg/L	200	**11,100**	22.8	6.90	6.93	55 J	11.3	0.99	149	4.10	4 U	4 U
1,1-DCA	µg/L	3,700	2,370	59.6	928	192	668	388	5.5	333	62.6	15.3	19 UJ
1,2-DCA	µg/L	5	25 U	2.00 U	1.00 U	0.4 U	40 U	4 U	0.5 U	4.00 U	2.00 U	4 U	4 U
Chloroethane	µg/L	--	288	708	6,220	12,600	11,800	4,570 J	0.72	1,880	890	1,490	1,930
PCE	µg/L	5	**31.5**	1.05 J	**5.25**	3.29	40 UJ	5 J	**7.23**	4.20	1.60 J	4 U	4 U
TCE	µg/L	5	**16.7** J	2.00 U	2.28	**5.29**	40 UJ	2.6 J	**43**	2.80 J	2.00 U	4 U	4 U
1,1-DCE	µg/L	7	**905**	**14.7**	**26.7**	**89.6**	**46** J	19	6.09	**51.0**	1.50 J	4 U	4 U
cis-1,2-DCE	µg/L	70	31.9	2.00 U	11.7	36.9	40 UJ	4 U	**83.4**	9.30	5.80	3.7 J	5
trans-1,2-DCE	µg/L	100	25 U	2.00 U	1.00 U	0.22 J	40 U	4 U	12.2	4.00 U	2.25	4 U	2.1 J
VC	µg/L	2	**13.5** J	**3.70**	**15.4**	**40.5**	**41**	33.4	**5.18**	**23.8**	**4.40**	**3.5** J	**4.6**
Dissolved Hydrocarbon Gases													
Methane	µg/L	--	539	13,000	8,500	10,000	15,000	11,000	31.5	15,000	4,200	5,200	11,000
Ethane	µg/L	--	0.54 J	1.0 U	1.0 U	1 U	1 U	1 U	0.15 J	2.5	1.0 U	1 U	1 U
Ethene	µg/L	--	1.92	4.8	3.3	3.9	14	15	0.76 J	17	8.1	6	5.8
General Chemistry													
Chloride	mg/L	--	57	10.3	48.8	68.4	18.2	14.2	12	16.2	20.5	23.4	28.1
Nitrate	mg/L	10	5 U	0.250 U	0.250 U	0.25 U	0.25 U	0.25 U	5 U	0.250 U	0.250 U	0.25 U	0.25 U
Sulfate	mg/L	--	10 U	1.00 U	1.00 U	1 U	1 U	1 U	10 U	1.00 U	1.00 U	1 U	1 U
Alkalinity	mg/L	--	128	85.0	534	420	123	109	112	154.0	753	780	732
Total Organic Carbon													
Total Organic Carbon	mg/L	--	5	NA	461	154	20.3	11.5	13	NA	369	29	42.7
Metals													
Iron	mg/L	--	4	NA	NA	NA	NA	NA	3.21	NA	NA	NA	NA
Sodium	mg/L	--	29	NA	NA	NA	NA	NA	11.6	NA	NA	NA	NA
Parameters													
ORP	mV	--	28.7	-2.6	-30.0	-49.5	-8.8	-85.9	33.1	-34.2	-71.9	-93	-88.9
Dissolved Oxygen	mg/L	--	0.86	0.27	0.08	0.1	0.32	0.14	0.64	0.23	0.08	0.24	0.37

Table 1. FCCA String 3 EISB Performance Monitoring Analytical Results

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Parameter	Units	Cleanup Standard	Injection Area Well PW-94A							Near Injection Area Well PW-69A				
			Baseline 5/10	Inj #2 Baseline 5/19	10/19	4/20	7/20	9/20	12/20	Baseline 5/10	Inj #2 Baseline 5/19	10/19	4/20	9/20
CVOCs														
1,1,1- TCA	µg/L	200	39	**748**	**233**	**476**	**389**	**262**	**322**	**368**	86.0	2.44	47.2	353
1,1-DCA	µg/L	3,700	25.7	220	231	562	582	547	277	246	47.6	45.1	151	460
1,2-DCA	µg/L	5	0.5 U	4.00 U	2.00 U	4.00 U	2.00 U	4.00 U	4.00 U	5.00 U	2.00 U	0.400 U	0.400 U	0.400 U
Chloroethane	µg/L	--	85.5	79.0	1,680	511	944	870	306	72.6	92.4	32.3	342	289
PCE	µg/L	5	0.5 U	4.00 U	2.70	4 U	2 U	4 U	4.00 U	**8.21**	**5.95**	1.38	**5.63**	**7.41**
TCE	µg/L	5	0.31 J	4.00 U	1.50 J	4 U	2 U	4 U	4.00 U	**5.3**	2.00 U	0.350 J	0.87	1.04
1,1-DCE	µg/L	7	1.9	**57.8**	**80.6**	**44.2** J	**46.7**	**42**	**36.6**	**31.2**	**9.95**	**7.99**	**23.8**	**69.5**
cis-1,2-DCE	µg/L	70	1.2	4.00 U	2.35	4 U	2 U	4 U	4.00 U	5.2 J	6.80	7.67	12.5	4.57
trans-1,2-DCE	µg/L	100	0.5 U	4.00 U	2.00 U	4 U	2 U	4 U	4.00 U	5 U	2.00 U	0.400 U	0.400 U	0.400 U
VC	µg/L	2	1.7	**4.60**	**24.8**	**11.7**	**12**	**11.2**	**8.9**	**4.8** J	**2.20**	1.39	**8.89**	**6.59**
Dissolved Hydrocarbon Gases														
Methane	µg/L	--	NA	4,800	6,700	16,000	NA	14,000	NA	890	2,700	4,100	7,700	9,400
Ethane	µg/L	--	NA	1.8	1.5	1.3	NA	1 U	NA	0.12 J	1.0 U	1.0 U	1 U	1 U
Ethene	µg/L	--	NA	1.9	19	10	NA	10	NA	0.13 J	1.0 U	1.0 U	1.8	2.1
General Chemistry														
Chloride	mg/L	--	13	20.2	16.9	13.6	NA	11.8	NA	12	14.8	9.49	12.9	10.8
Nitrate	mg/L	10	5 U	0.250 U	0.250 U	0.25 U	NA	0.25 U	NA	5 U	0.250 U	0.250 U	0.25 U	0.25 U
Sulfate	mg/L	--	10 U	1.00 U	1.00 U	1 U	NA	1 U	NA	10 U	1.00 U	1.00 U	1 U	1 U
Alkalinity	mg/L	--	174	103	152	112	NA	121	NA	14	100	96.9	131	116
Total Organic Carbon														
Total Organic Carbon	mg/L	--	5 U	NA	82.2	6.67	NA	5.13	NA	5 U	NA	14.5	19.7	4.22
Metals														
Iron	mg/L	--	5.4	NA	NA	NA	NA	NA	NA	0.65	NA	NA	NA	NA
Sodium	mg/L	--	32	NA	NA	NA	NA	NA	NA	12.5	NA	NA	NA	NA
Parameters														
ORP	mV	--	-66.2	-101.3	-99.5	-123.6	-46	-82.2	-136.7	-98.5	-72.7	-99.4	-72	-83.4
Dissolved Oxygen	mg/L	--	0.36	1.08	0.07	0.12	0.35	0.47	0.32	0.29	0.53	0.08	0.18	0.42

Table 1. FCCA String 3 EISB Performance Monitoring Analytical Results

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Parameter	Units	Cleanup Standard	Near Injection Area Well								
			PW-95A					PW-101A			
			Baseline 5/10	Inj #2 Baseline 5/19	10/19	4/20	9/20	Baseline 8/10	Inj #2 Baseline 5/19	10/19	9/20
CVOCs											
1,1,1- TCA	µg/L	200	**348**	**805**	**568**	**271**	**324**	0.08 J	4.00 U	3.35	0.400 U
1,1-DCA	µg/L	3,700	152	564	1,830	334	210	1.56	19.4	30.8	0.500
1,2-DCA	µg/L	5	0.500 U	1.00 U	4.00 U	4.00 U	4.00 U	0.5 U	4.00 U	0.400 U	0.400 U
Chloroethane	µg/L	--	25.2	180	668	175	152 J	0.5 U	1,500	329	402
PCE	µg/L	5	1.51	1.68	3.70 J	4.00 U	4.00 U	0.5 U	4.00 U	0.400 U	0.400 U
TCE	µg/L	5	2.3	2.88	4.50	2.2 J	2.5 J	0.12 J	4.20	1.63	0.340 J
1,1-DCE	µg/L	7	**15.2**	**68.2**	**191**	**49.9**	**65.4**	0.16 J	4.00 U	2.13	0.200 J
cis-1,2-DCE	µg/L	70	4.2	7.35	7.30	3.5 J	2.9 J	0.19 J	5.00	2.50	2.23
trans-1,2-DCE	µg/L	100	0.500 U	1.00 U	4.00 U	4.00 U	4.00 U	0.5 U	4.00 U	0.400 U	0.4 U
VC	µg/L	2	**3.8**	0.900 J	**6.10**	**3.2** J	**2.8** J	0.5 U	**4.30**	0.810	0.62
Dissolved Hydrocarbon Gases											
Methane	µg/L	--	NA	720	1,700	3,300	4,600	23.6	NA	NA	8,900
Ethane	µg/L	--	NA	1.0 U	1.0 U	1 U	1 U	0.079 J	NA	NA	1 U
Ethene	µg/L	--	NA	1.0 U	1.6	2.7	4	0.05 U	NA	NA	1.2
General Chemistry											
Chloride	mg/L	--	17	14.5	14.5	11	11.2	21	NA	NA	11.6
Nitrate	mg/L	10	5 U	0.600	0.250 U	0.525	0.694	5 U	NA	NA	0.25 U
Sulfate	mg/L	--	10 U	4.00	1.43	4.36	3.93	10 U	NA	NA	0.556 J
Alkalinity	mg/L	--	46	101	110	100	101	11	NA	NA	430
Total Organic Carbon											
Total Organic Carbon	mg/L	--	5 U	NA	4.17	1.6	1.7	1.08	NA	NA	NA
Metals											
Iron	mg/L	--	0.75	NA	NA	NA	NA	0.37	NA	NA	NA
Sodium	mg/L	--	20	NA	NA	NA	NA	12.3	NA	NA	NA
Parameters											
ORP	mV	--	-91.2	28.1	-119	-5.5	4.6	48.2	26.6	-54.7	-62.9
Dissolved Oxygen	mg/L	--	0.15	0.26	0.06	0.12	0.39	0.48	0.37	0.14	0.35

Table 1. FCCA String 3 EISB Performance Monitoring Analytical Results

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Parameter	Units	Cleanup Standard	Perimeter Area Well						
			FW-1						
			Baseline 9/10	Inj #2 Baseline 8/19	10/19	4/20	7/20	9/20	12/20
CVOCs									
1,1,1- TCA	µg/L	200	**1,922**	**511**	5.45	8.16	0.44	0.35 J	0.4 U
1,1-DCA	µg/L	3,700	366	480	9.80	103	3.09	3.64	2.78
1,2-DCA	µg/L	5	0.500 U	0.400 U	0.400 U	0.400 U	0.400 U	0.400 U	0.400 U
Chloroethane	µg/L	--	38.1	310	5.00 U	360	7.4	5.00 U	5.00 U
PCE	µg/L	5	1.89	2.16	**6.78**	0.81	0.46	0.32 J	0.33 J
TCE	µg/L	5	3.58	3.52	**6.78**	2.32	**5.07**	**5.19**	4.08
1,1-DCE	µg/L	7	**239**	**110**	1.36	4.44	0.39 J	0.50	0.26 J
cis-1,2-DCE	µg/L	70	9.86	6.68	9.24	3.97	5.9	10.1	6.07
trans-1,2-DCE	µg/L	100	0.5 U	0.400 U	0.430	0.28 J	0.36 J	0.58	0.57
VC	µg/L	2	**5.89**	**9.23**	0.770	**4.63**	0.92	**2.71**	**2.07**
Dissolved Hydrocarbon Gases									
Methane	µg/L	--	NA	NA	NA	NA	NA	NA	NA
Ethane	µg/L	--	NA	NA	NA	NA	NA	NA	NA
Ethene	µg/L	--	NA	NA	NA	NA	NA	NA	NA
General Chemistry									
Chloride	mg/L	--	NA	NA	NA	NA	NA	NA	NA
Nitrate	mg/L	10	NA	NA	NA	NA	NA	NA	NA
Sulfate	mg/L	--	NA	NA	NA	NA	NA	NA	NA
Alkalinity	mg/L	--	NA	NA	NA	NA	NA	NA	NA
Total Organic Carbon									
Total Organic Carbon	mg/L	--	NA	NA	NA	NA	NA	NA	NA
Metals									
Iron	mg/L	--	NA	NA	NA	NA	NA	NA	NA
Sodium	mg/L	--	NA	NA	NA	NA	NA	NA	NA
Parameters									
ORP	mV	--	NA	43.6	7.3	-14.3	97.9	34.4	-105.9
Dissolved Oxygen	mg/L	--	NA	2.9	0.17	4.73	0.05	0.32	0.35

Notes

First round of EISB injections occurred in 2010. String 3 EISB injections occurred between August 23 and 25, 2019.

-- = no applicable cleanup level

µg/L = micrograms per liter

CVOC = chlorinated volatile organic compound

DCA = dichloroethane

DCE = dichloroethene

EISB = enhanced in situ bioremediation

FCCA = Former Crucible Cleaning Area

Inj = injection

J = estimated value below reporting limit

mg/L = milligrams per liter

mV = millivolts

NA = not analyzed

ORP = oxidation-reduction potential

PCE = tetrachloroethene

TCA = trichloroethane

TCE = trichloroethene

U = not detected above reporting limit

VC = vinyl chloride

Bold indicates that the concentration meets or exceeds the cleanup standard. Refer to Quality Assurance Project Plan for the Sitewide Remedial Action Table B-4 for more details (GSI, 2015).

Table 2. Injection Summary, August 23–25, 2019

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

String 3 Temporary Well Number	Total Volume of Injected Substrate Solution [1] (gallons)	Approximate Injection Volume at Time of KB-1 Plus® Addition (liters)	Mass of KB-1 Plus® Injected [2] (kilgrams)
1	2,277	1,097	2.3
2	2,253	1,039	2.0
3	2,303	793	2.0
4	2,263	1,234	2.0
5	1,183	740	2.1
6	2,196	959	2.0
7	2,179	904	2.0
8	2,591	1,434	1.9
9	2,238	1,056	2.0
10	2,248	1,037	2.1
Totals	**21,731**	**10,293**	**20.4**

Notes

[1] Total substrate solution injection volumes were calculated from the mechanical flow meters on the injection manifold rather than the digital flow meters on each wellhead fitting, as they were deemed to be more accurate. The total volume calculated from the digital meters was 19,275 gallons.

[2] Mass of KB-1 Plus® injected in kg, and is approximately equal to volume in liters.

EISB = enhanced in situ bioremediation

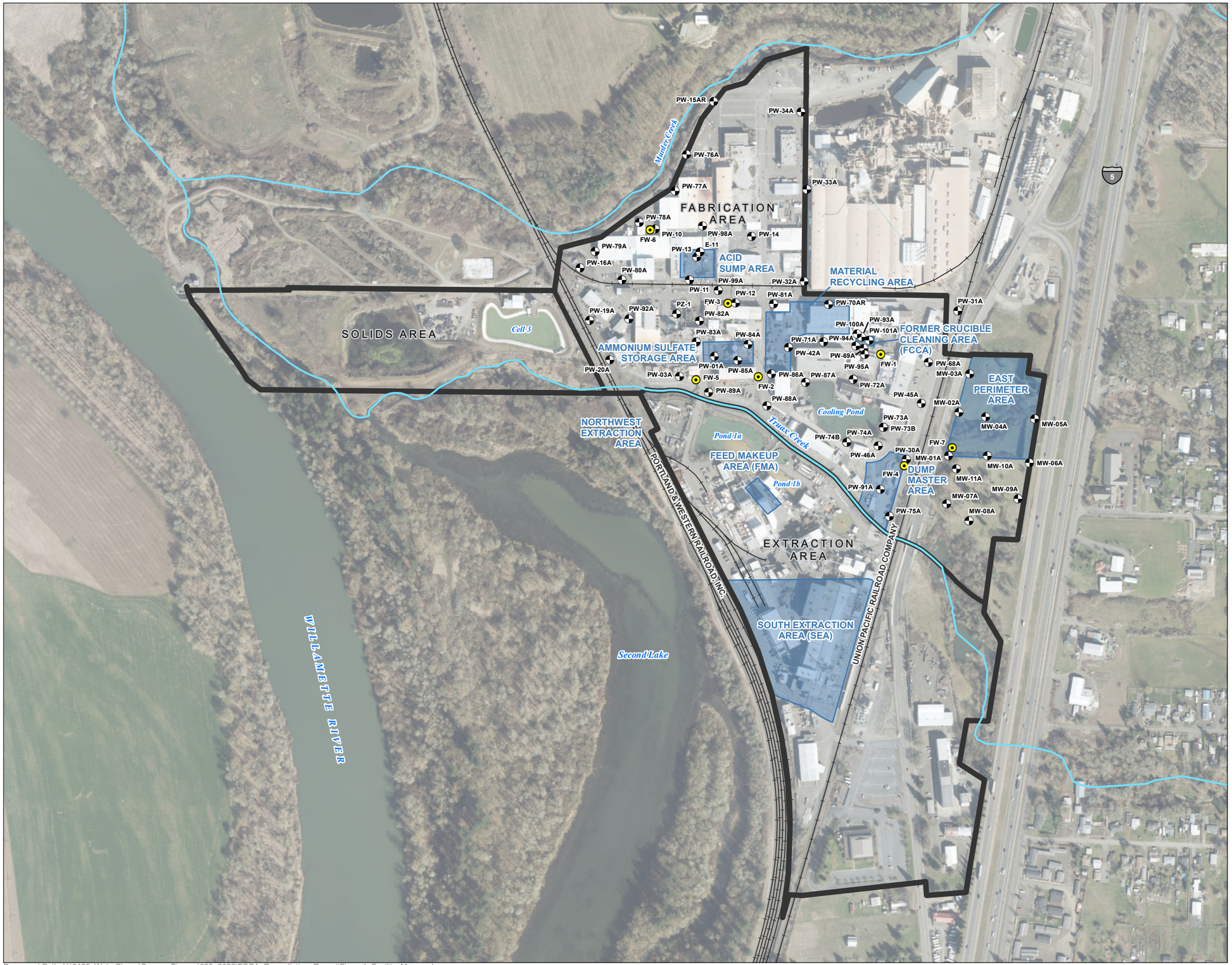
FCCA = Former Crucible Cleaning Area

Figures

FIGURE 1

Facility Map

ATI Millersburg Operations, Oregon



LEGEND

- Monitoring Well
- Extraction Well
- Watercourse
- Boundary
- Remediation Subarea
- Railroad

N

0 225 450 675

Feet

Date: June 14, 2021

Data Sources: Linn Co., ESRI, Digiglobe 2018

GSI Water Solutions, Inc.

Document Path: Y:\0168_Wah_Chang\Source_Figures\029_2020\FCCA_Remediation_Report\Figure1_Facility_Map.mxd

FIGURE 2

Temporary Injection Well Locations and Utility Schematic

ATI Millersburg Operations, Oregon

LEGEND

- 2019 Temporary Injection Well - String
- Monitoring Well
- Extraction Well
- 2010 Injection Well Location
- Refusal at Installation Point
- Utility at Installation Point
- Chemical Drain Basins to Waste Water Treatment (Approximate)
- Injection Tubing
- Chemical Drain Line
- Water Supply
- 5-foot Theoretical Radius of

NOTE

Temporary injection well locations were adjusted in the field to accomodate utilities, infrastructure, or points of refusal. Original location of injection point 9 altered due to electrical wires encountered during 5-ft clear out with vac truck.

N

0 10 20 30

Feet

Date: June 14, 2021
Data Sources: ATI, City of Albany GIS

GSI Water Solutions, Inc.

Document Path: Y:\0168_Wah_Chang\Source_Figures\029_2020\FCCA_Remediation_Report\Figure2_CCA_Injection_Schematic.mxd

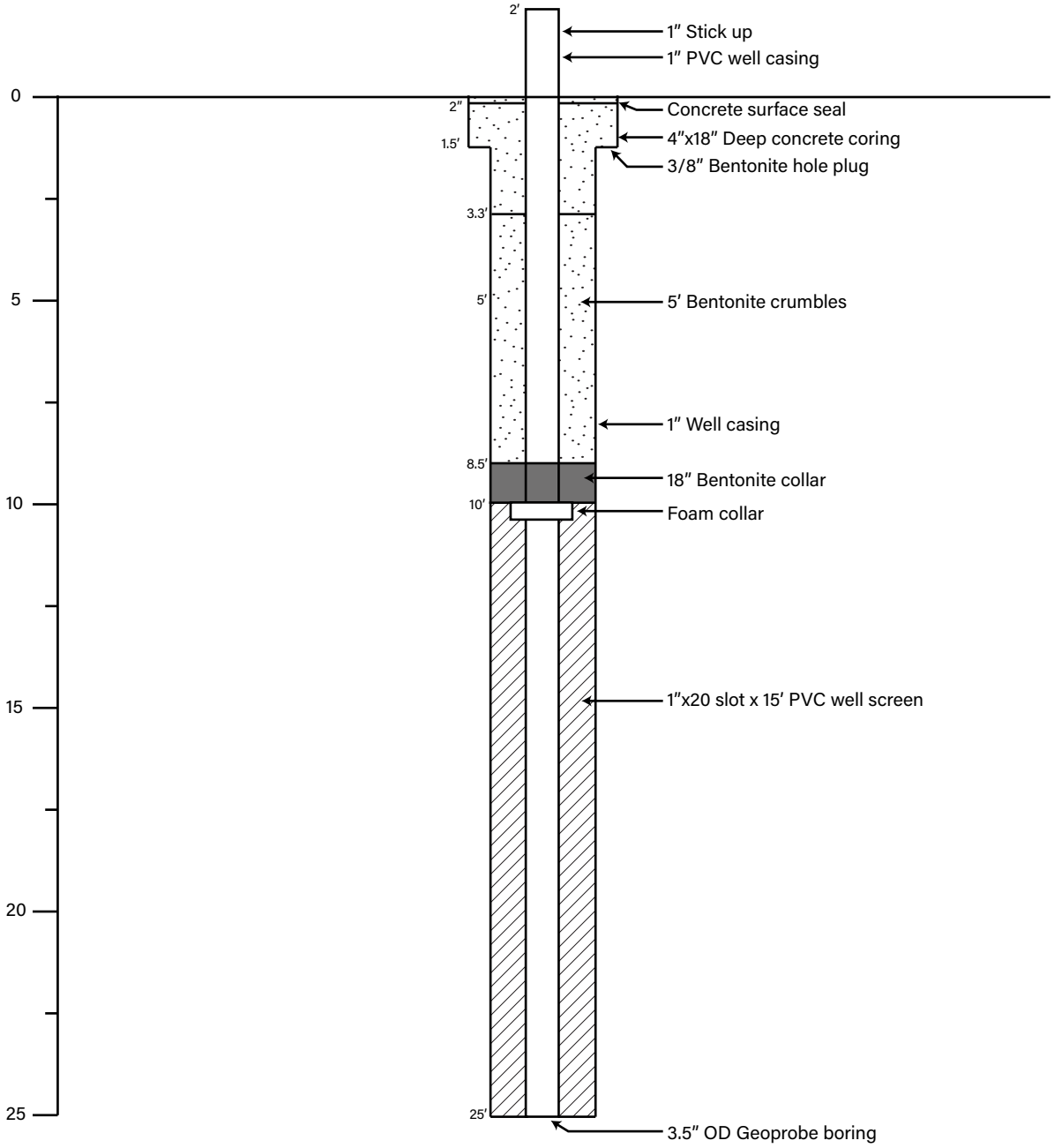


FIGURE 3

Temporary Injection Well Schematic

ATI Millersburg Operations, Oregon

NOTES
OD: Outer Diameter
PVC: Polyvinyl Chloride

GSI Water Solutions, Inc.

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FIGURE 4

Injection Volume Summary – Summer 2019

ATI Millersburg Operations, Oregon

LEGEND

- 2019 Temporary Injection Well - String 3
- Monitoring Well
- Extraction Well
- 2010 Injection Well Location
- Refusal at Installation Point
- Utility at Installation Point
- Chemical Drain Basins to Waste Water Treatment (Approximate)

INJECTION WELL LABEL

2	Temporary Well Number
2,303	Gallons of injected substrate[1]
2.0	Liters of injected KB-1 Plus

NOTE

Injection substrate was composed of 0.5% sodium bicarbonate buffered deoxygenated water with 5% Newman Zone.

N

0 10 20 30

Feet

Date: June 14, 2021
Data Sources: ATI

GSI Water Solutions, Inc.

Document Path: Y:\0168_Wah_Chang\Source_Figures\029_2020\FCCA_Remediation_Report\Figure4_CCA_Injection_Summary.mxd

PW-93A	Units	Baseline 5/10	6/15	Baseline 5/19	10/19	4/20	9/20	12/20
ORP	mV	28.7	-71.2	-2.6	-30.0	-49.5	-8.8	-85.9
DO	mg/L	0.86	0.18	0.27	0.08	0.1	0.32	0.14

PW-101A	Units	Baseline 8/10	6/15	Baseline 5/19	10/19	9/20
ORP	mV	48.2	70.9	26.6	-54.7	-62.9
DO	mg/L	0.48	0.37	0.37	0.14	0.35

PW-100A	Units	Baseline 8/10	6/15	Baseline 5/19	10/19	4/20	9/20
ORP	mV	33.1	-54.1	-34.2	-71.9	-93	-88.9
DO	mg/L	0.64	0.22	0.23	0.08	0.24	0.37

PW-69A	Units	Baseline 5/10	6/15	Baseline 5/19	10/19	4/20	9/20
ORP	mV	-98.5	-91.2	-72.7	-99.4	-72	-83.4
DO	mg/L	0.29	0.34	0.53	0.08	0.18	0.42

PW-94A	Units	Baseline 5/10	6/15	Baseline 5/19	10/19	4/20	7/20	9/20	12/20
ORP	mV	-66.2	-100	-101.3	-99.5	-124	-46	-82.2	-137
DO	mg/L	0.36	0.2	1.08	0.07	0.12	0.35	0.47	0.32

PW-95A	Units	Baseline 5/10	6/15	Baseline 5/19	10/19	4/20	9/20
ORP	mV	-91.2	57.7	28.1	-119	-5.5	4.6
DO	mg/L	0.15	0.42	0.26	0.06	0.12	0.39

FW-1	Units	Baseline 9/10	6/15	Baseline 5/19	10/19	4/20	7/20	9/20	12/20
ORP	mV	NA	NA	43.6	7.3	-14.3	97.9	34.4	-106
DO	mg/L	NA	NA	2.9	0.17	4.73	0.05	0.32	0.35

FIGURE 5

Field Parameter Trends and Distribution

ATI Millersburg Operations, Oregon

LEGEND

Well Type

- Source Area
- Injection Area
- Perimeter Area

NOTES

First round of EISB injections occurred in 2010.
String 3 EISB injections occurred between August 23 and 25, 2019.

EISB: enhanced in situ bioremediation
ORP: oxidation reduction potential
DO: dissolved oxygen
mV: millivolts
mg/L: milligrams per liter
NA: not available

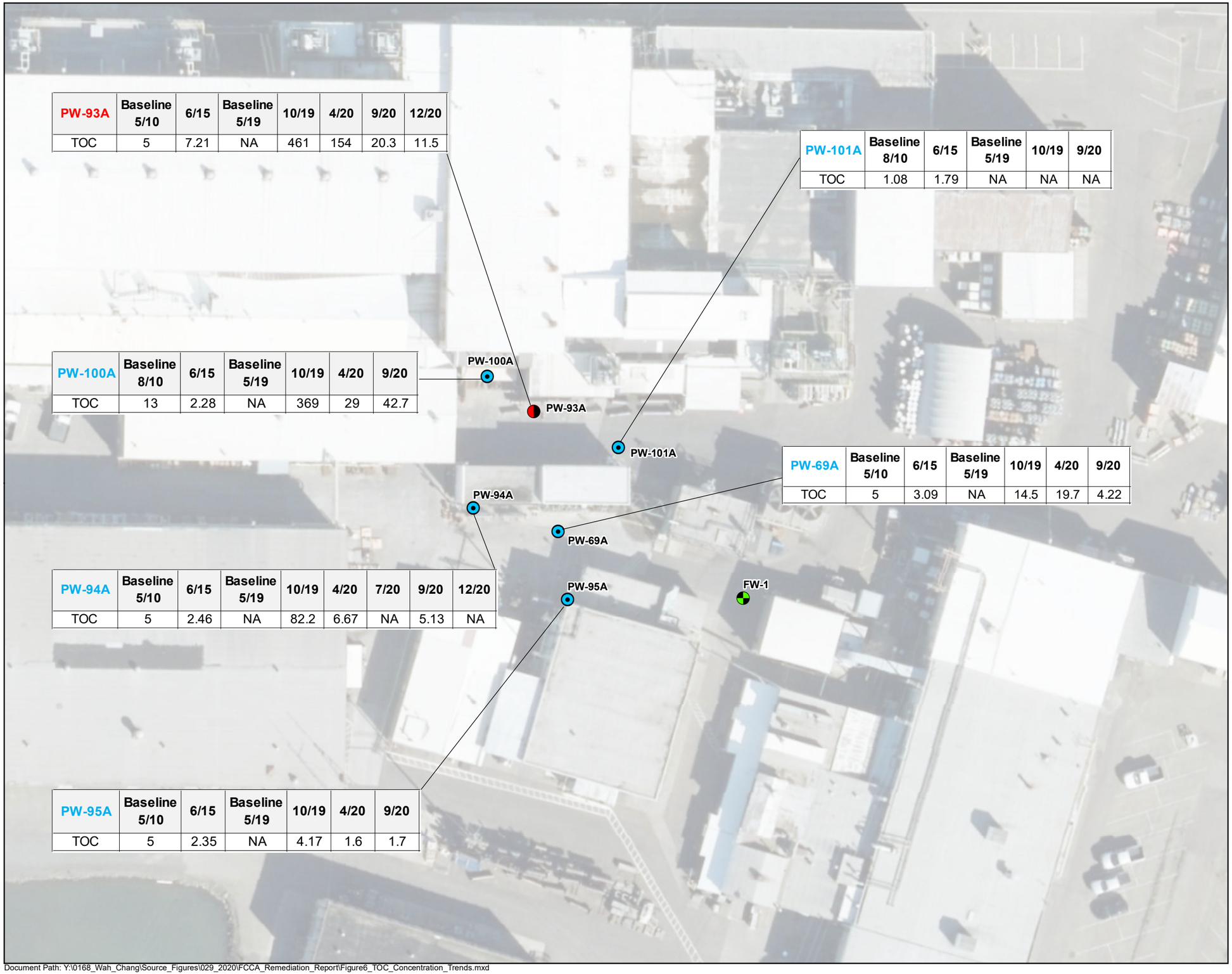
N

0 20 40 60
Feet

Date: June 14, 2021
Data Sources: ATI, City of Albany GIS, GeoTerra, 2019.

GSI Water Solutions, Inc.

Document Path: Y:\0168_Wah_Chang\Source_Figures\029_2020\FCCA_Remediation_Report\Figure5_Field_Parameter Trends.mxd



PW-93A	Baseline 5/10	6/15	Baseline 5/19	10/19	4/20	9/20	12/20
TOC	5	7.21	NA	461	154	20.3	11.5

PW-101A	Baseline 8/10	6/15	Baseline 5/19	10/19	9/20
TOC	1.08	1.79	NA	NA	NA

PW-100A	Baseline 8/10	6/15	Baseline 5/19	10/19	4/20	9/20
TOC	13	2.28	NA	369	29	42.7

PW-69A	Baseline 5/10	6/15	Baseline 5/19	10/19	4/20	9/20
TOC	5	3.09	NA	14.5	19.7	4.22

PW-94A	Baseline 5/10	6/15	Baseline 5/19	10/19	4/20	7/20	9/20	12/20
TOC	5	2.46	NA	82.2	6.67	NA	5.13	NA

PW-95A	Baseline 5/10	6/15	Baseline 5/19	10/19	4/20	9/20
TOC	5	2.35	NA	4.17	1.6	1.7

FIGURE 6

TOC Concentration Trends and Distribution

ATI Millersburg Operations, Oregon

LEGEND

Well Type

- Source Area
- Injection Area
- Perimeter Area

All concentrations are in mg/L.

NOTES

1. First round of EISB injections occurred in 2010. String 3 EISB injections occurred between August 23 and 25, 2019.
2. No TOC data is available for FW-1 in the time period shown.

EISB: enhanced in situ bioremediation
mg/L: milligrams per liter
NA: not analyzed
TOC: total organic carbon

N

0 20 40 60
Feet

Date: June 14, 2021
Data Sources: ATI, City of Albany GIS, GeoTerra, 2019.

GSI Water Solutions, Inc.

Document Path: Y:\0168_Wah_Chang\Source_Figures\029_2020\FCCA_Remediation_Report\Figure6_TOC_Concentration_Trends.mxd

PW-93A	Baseline 5/10	6/15	Baseline 5/19	10/19	4/20	9/20	12/20
1,1,1- TCA	**11,100**	28.7	22.8	6.90	6.93	55 J	11.3
1,1-DCA	2370	83.1	59.6	928	192	668	388
CA	288	175	708	6,220	12,600	11,800	4,570 J
PCE	**31.5**	0.35 J	1.05 J	**5.25**	3.29	40 UJ	**5** J
TCE	**16.7** J	0.2 J	2.0 U	2.28	**5.29**	40 UJ	2.6 J
cis-1,2-DCE	31.9	0.32 J	2 U	11.7	36.9	40 UJ	4 U
VC	**13.5** J	**4.1**	**3.70**	**15.4**	**40.5**	**41**	**33.4**
Ethane	0.54 J	0.13 J	1.0 U	1.0 U	1 U	1 U	1 U

PW-101A	Baseline 8/10	6/15	Baseline 5/19	10/19	9/20
1,1,1- TCA	0.08 J	0.5 U	4.00 U	3.35	0.400 U
1,1-DCA	1.56	1.85	19.4	30.8	0.500
CA	0.5 U	0.5 U	1,500	329	402
PCE	0.5 U	0.5 U	4.00 U	0.400 U	0.400 U
TCE	0.12 J	0.5 U	4.20	1.63	0.340 J
cis-1,2-DCE	0.19 J	1.57	5.00	2.5	2.23
VC	0.5 U	0.5 U	**4.30**	0.810	0.62
Ethane	0.08 J	0.5 U	NA	NA	1 U

PW-100A	Baseline 8/10	6/15	Baseline 5/19	10/19	4/20	9/20
1,1,1- TCA	0.99	0.5 U	149	4.10	4 U	4 U
1,1-DCA	5.5	2.2	333	62.6	15.3	19 UJ
CA	0.72	11.5	1,880	890	1490	1930
PCE	**7.23**	0.5 U	4.20	1.60 J	4 U	4 U
TCE	**43**	0.5 U	2.80 J	2.00 U	4 U	4 U
cis-1,2-DCE	**83.4**	0.21 J	9.3	5.80	3.7 J	5
VC	**5.18**	0.67	**23.8**	**4.40**	**3.5** J	**4.6**
Ethane	0.15 J	1.09	2.5	1.0 U	1 U	1 U

PW-69A	Baseline 5/10	6/15	Baseline 5/19	10/19	4/20	9/20
1,1,1- TCA	**368**	95.4	86.0	2.44	47.2	**353**
1,1-DCA	246	38	47.6	45.1	151	460
CA	72.6	28.4	92.4	32.3	342	289
PCE	**8.21**	3.61	**5.95**	1.38	**5.63**	**7.41**
TCE	**5.3**	0.43 J	2.00 U	0.350 J	0.87	1.04
cis-1,2-DCE	5.2 J	5.05	6.80	7.67	12.5	4.57
VC	**4.8** J	1.42	**2.20**	1.39	**8.89**	**6.59**
Ethane	0.12 J	0.15 J	1.0 U	1.0 U	1 U	1 U

PW-94A	Baseline 5/10	6/15	Baseline 5/19	10/19	4/20	7/20	9/20	12/20
1,1,1- TCA	39	**1,830**	**748**	**233**	**476**	**389**	**262**	**322**
1,1-DCA	25.7	166	220	231	562	582	547	277
CA	85.5	71.9	79.0	1,680	511	944	870	306
PCE	0.5 U	1.31 J	4.00 U	2.70	4 U	2 U	4 U	4 U
TCE	0.31 J	1.58 J	4.00 U	1.50 J	4 U	2 U	4 U	4 U
cis-1,2-DCE	1.2	2.19 J	4.0 U	2.35	4 U	2 U	4 U	4 U
VC	1.7	**2.23** J	**4.60**	**24.8**	**11.7**	**12**	**11.2**	**8.9**
Ethane	NA	0.22 J	1.8	1.5	1.3	NA	1 U	NA

PW-95A	Baseline 5/10	6/15	Baseline 5/19	10/19	4/20	9/20
1,1,1- TCA	**348**	**259**	**805**	**568**	**271**	**324**
1,1-DCA	152	45.8	564	1,830	334	210
CA	25.2	5.02	180	668	175	152 J
PCE	1.51	0.68	1.68	3.70 J	4.00 U	4.00 U
TCE	2.3	0.65	2.88	4.50	2.2 J	2.5 J
cis-1,2-DCE	4.2	2.05	7.35	7.30	3.5 J	2.9 J
VC	**3.8**	1.04	0.900 J	**6.10**	**3.2** J	**2.8** J
Ethane	NA	0.37 U	1.0 U	1.0 U	1 U	1 U

FW-1	Baseline 9/10	6/15	Baseline 8/19	10/19	4/20	7/20	9/20	12/20
1,1,1- TCA	**1,922**	**234**	**511**	5.45	8.16	0.44	0.35 J	0.4 U
1,1-DCA	366	364	480	9.80	103	3.09	3.64	2.78
CA	38.1	519	310	5.00 U	360	7.4	5.00 U	5.00 U
PCE	1.89	0.92	2.16	**6.78**	0.81	0.46	0.32 J	0.33 J
TCE	3.58	1.6	3.52	**6.78**	2.32	**5.07**	**5.19**	4.08
cis-1,2-DCE	9.86	4.59	6.68	9.24	3.97	5.9	10.1	6.07
VC	**5.89**	**13**	**9.23**	0.770	**4.63**	0.92	**2.71**	**2.07**
Ethane	NA	NA	NA	NA	NA	NA	NA	NA

PW-100A
PW-93A
PW-101A
PW-94A
PW-69A
PW-95A
FW-1

FIGURE 7

CVOC Concentration Trends and Distribution

ATI Millersburg Operations, Oregon

LEGEND

Well Type

- Source Area
- Injection Area
- Perimeter Area

All concentrations are in µg/L.

NOTES

1. First round of EISB injections occurred in 2010. String 3 EISB injections occurred between August 23 and 25, 2019.
2. Bolded values represent exceedances to the cleanup standard. Refer to Quality Assurance Project Plan for Sitewide Remedial Action Table B-4 (GSI, 2016).
3. Green shading denotes 1,1,1-TCA and associated daughter products for ease of reviewing.

CVOC: chlorinated volatile organic compound
EISB: enhanced in situ bioremediation
TCA: trichloroethane
DCA: dichloroethane
CA: chloroethane
PCE: tetrachloroethene
TCE: trichloroethene
DCE: dichloroethene
VC: vinyl chloride
U: analyte was not detected above the detection limit.
J: result is an estimate.
µg/L: micrograms per liter
NA: not analyzed

Cleanup Standards:
1,1,1-TCA: 200 µg/L PCE: 5 µg/L
1,1-DCA: 3700 µg/L TCE: 5 µg/L
cis-1,2-DCE: 70 µg/L VC: 2 µg/L
There is no cleanup standard for CA or ethane.

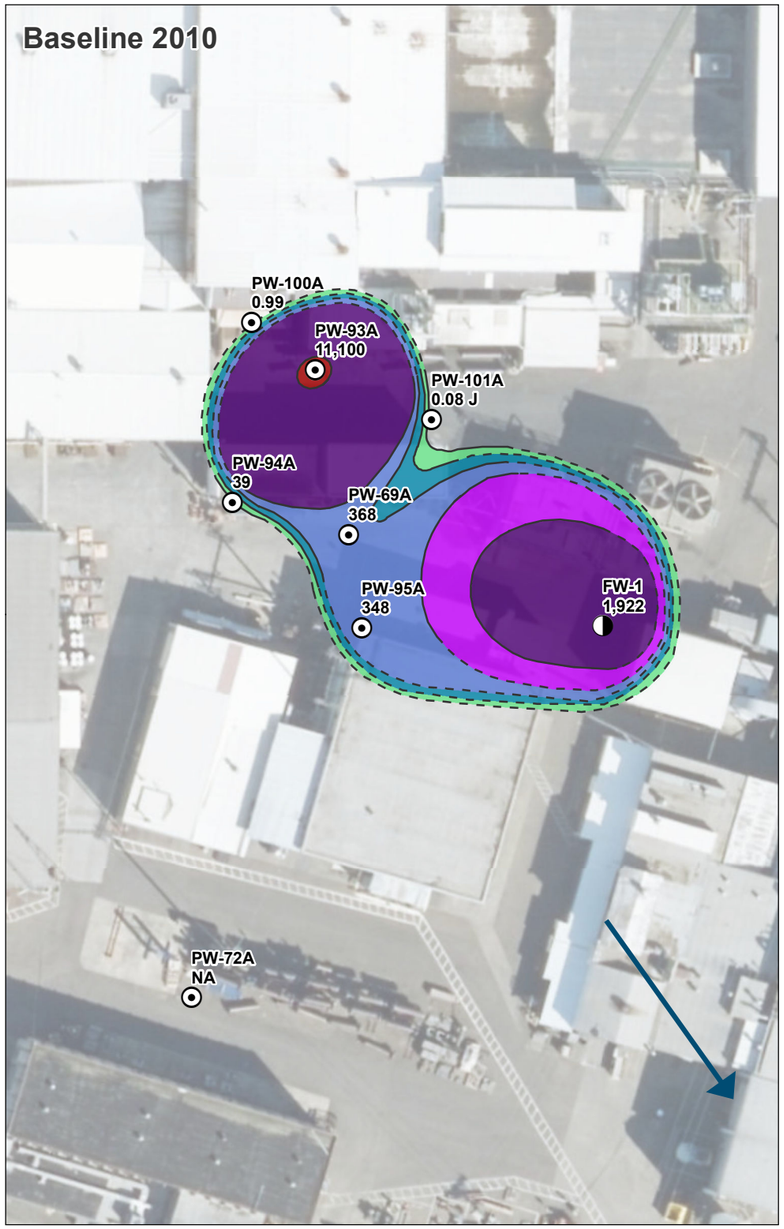
N

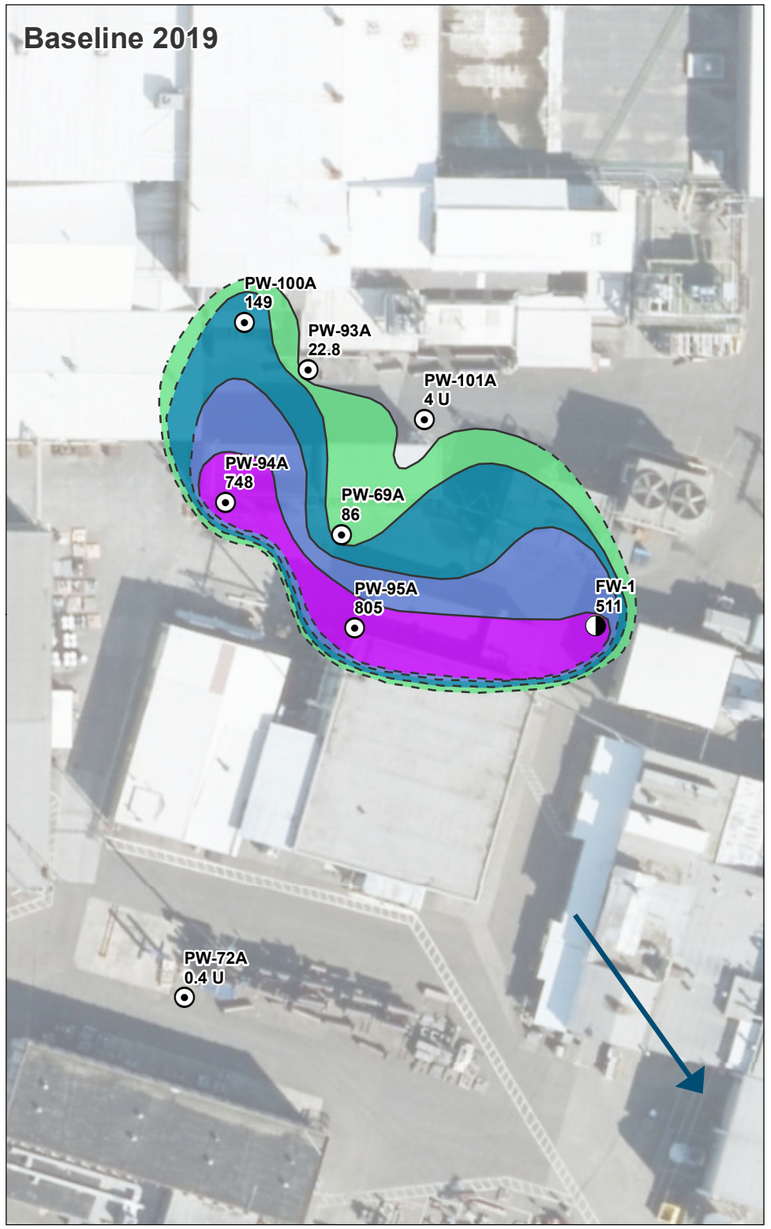
0 20 40 60
Feet

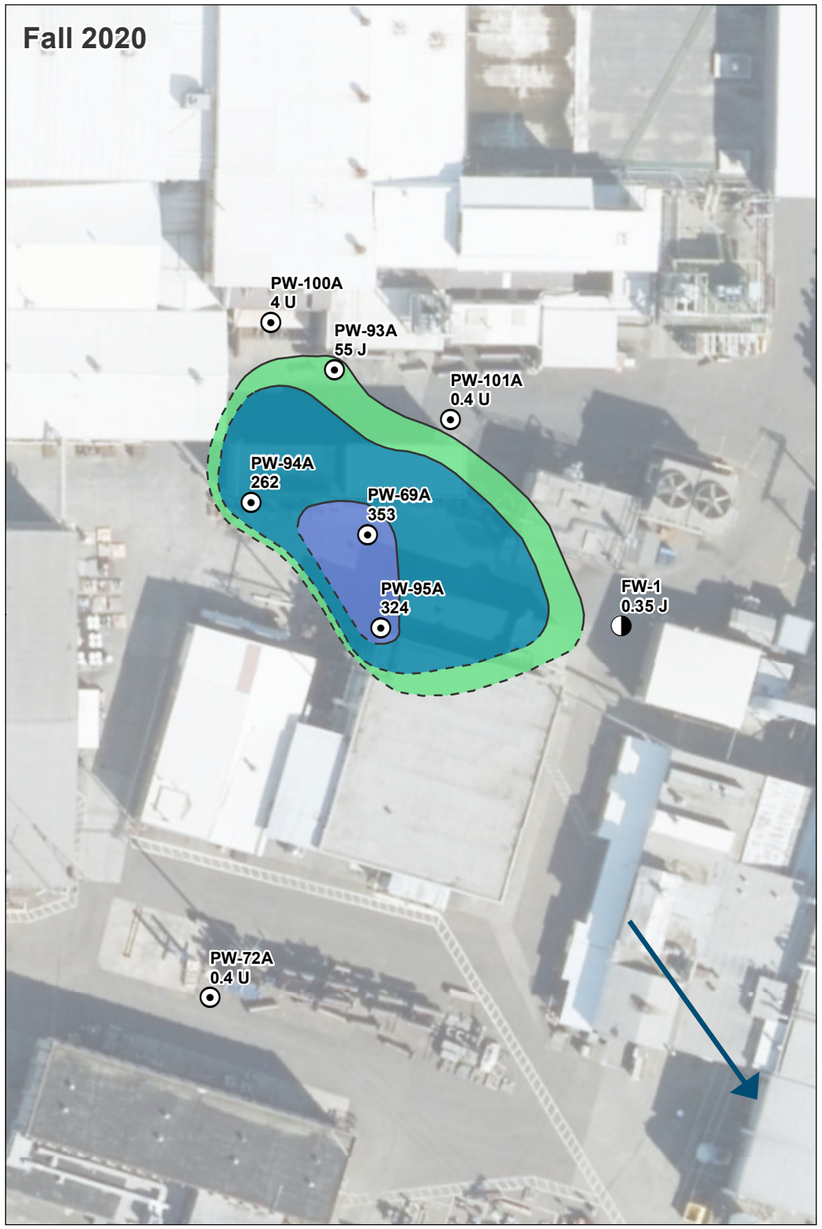
Date: June 14, 2021
Data Sources: ATI, City of Albany GIS, GeoTerra, 2019.

GSI Water Solutions, Inc.

Document Path: Y:\0168_Wah_Chang\Source_Figures\029_2020\FCCA_Remediation_Report\Figure7_CVOC_Concentration_Trends.mxd







NOTES

1. Baseline 2010 TCA concentrations are from the spring 2010 monitoring event (May 2010), with the exception of FW-1 (September 2010), PW-101A (August 2010), and PW-100A (August 2010).
2. Baseline 2019 TCA concentrations are from the spring 2019 monitoring event (May 2019), with the exception of extraction well FW-1, which was sampled in August 2019.
3. Fall 2020 concentrations are from the fall 2020 monitoring event (September 2020).
4. Cleanup level for TCA is 200 µg/L.

TCA: 1,1,1-trichloroethane
µg/L: micrograms per liter
J: estimated value
NA: not available
U: not detected above reporting limit

Date: June 14, 2021
Data Sources: Linn Co., ESRI, Geoterra Inc. 2019

LEGEND

- Monitoring Well *TCA Concentration in µg/L*
- Extraction Well *TCA Concentration in µg/L*
- Groundwater Flow Direction
- TCA Concentration Boundary (dashed where inferred)

TCA Concentrations (µg/L)

- 50 - 100
- 101 - 300
- 301 - 500
- 501 - 1,000
- 1,001 - 10,000
- > 10,000

N

0 25 50 75
Feet

GSI Water Solutions, Inc.

FIGURE 8

TCA Isopleths for Baseline 2010, Baseline 2019, and Fall 2020

ATI Millersburg Operations, Oregon

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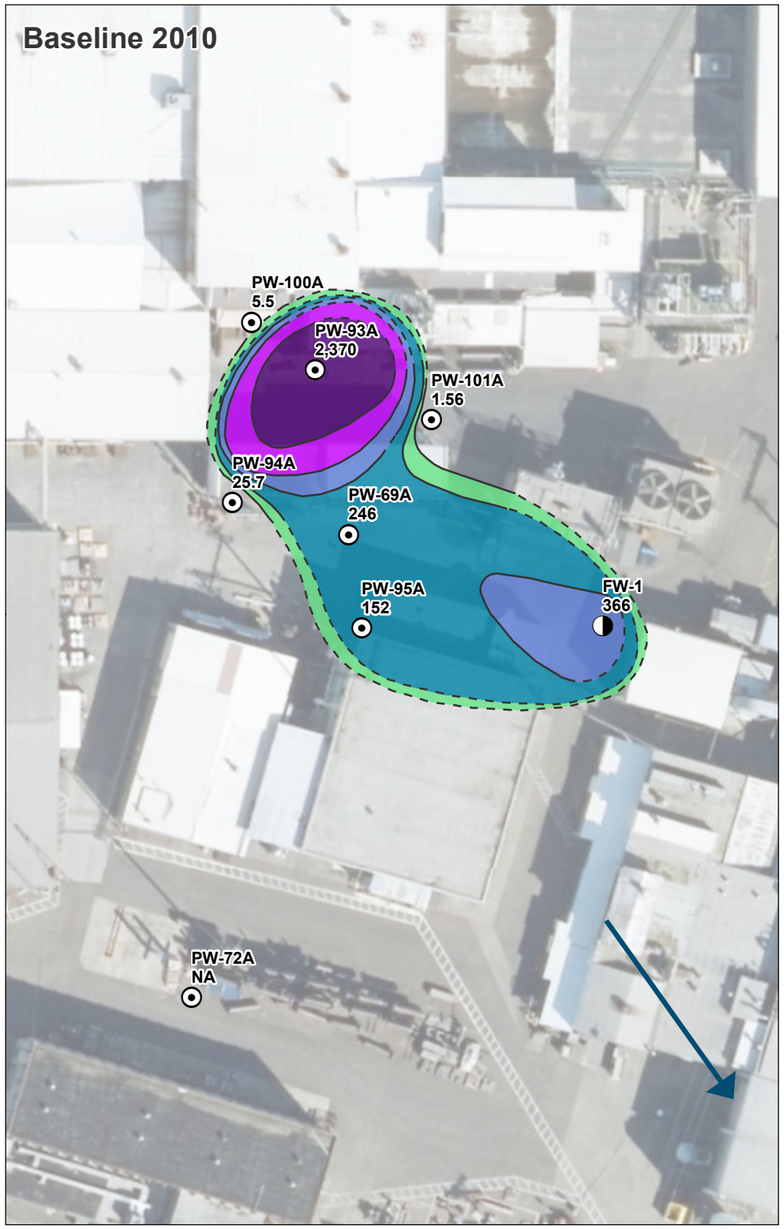
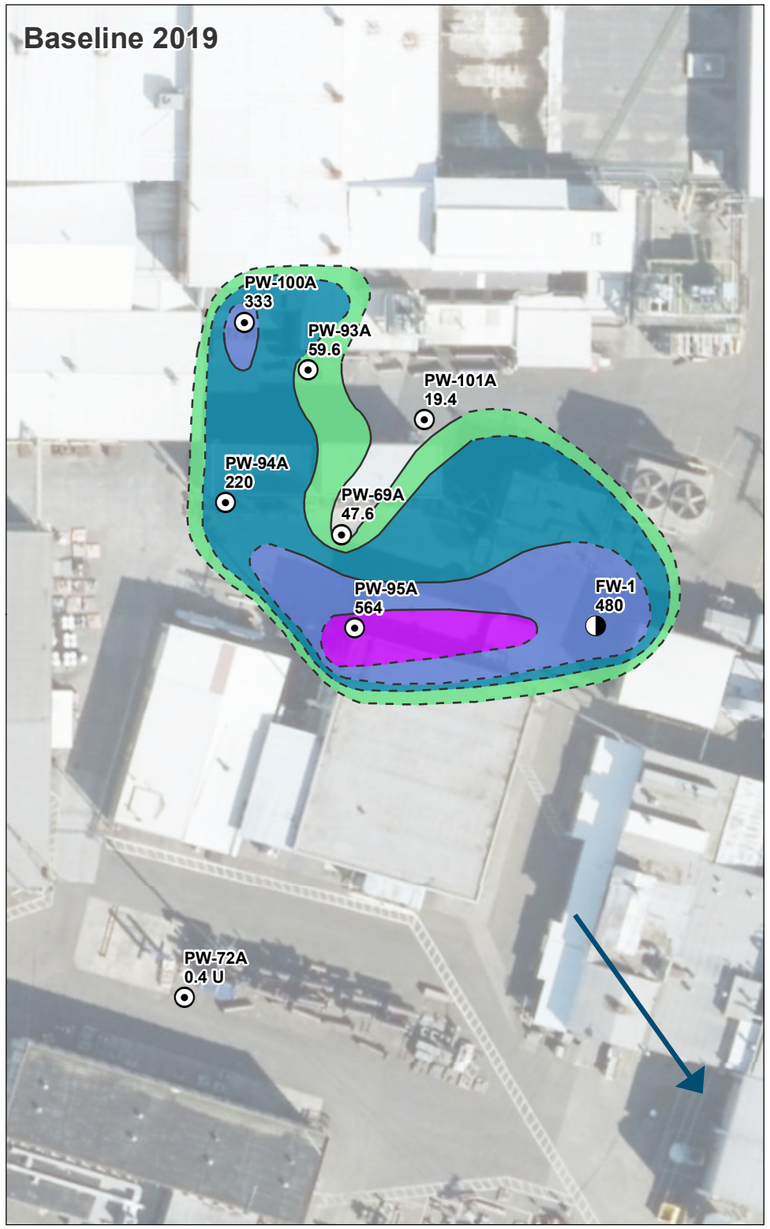
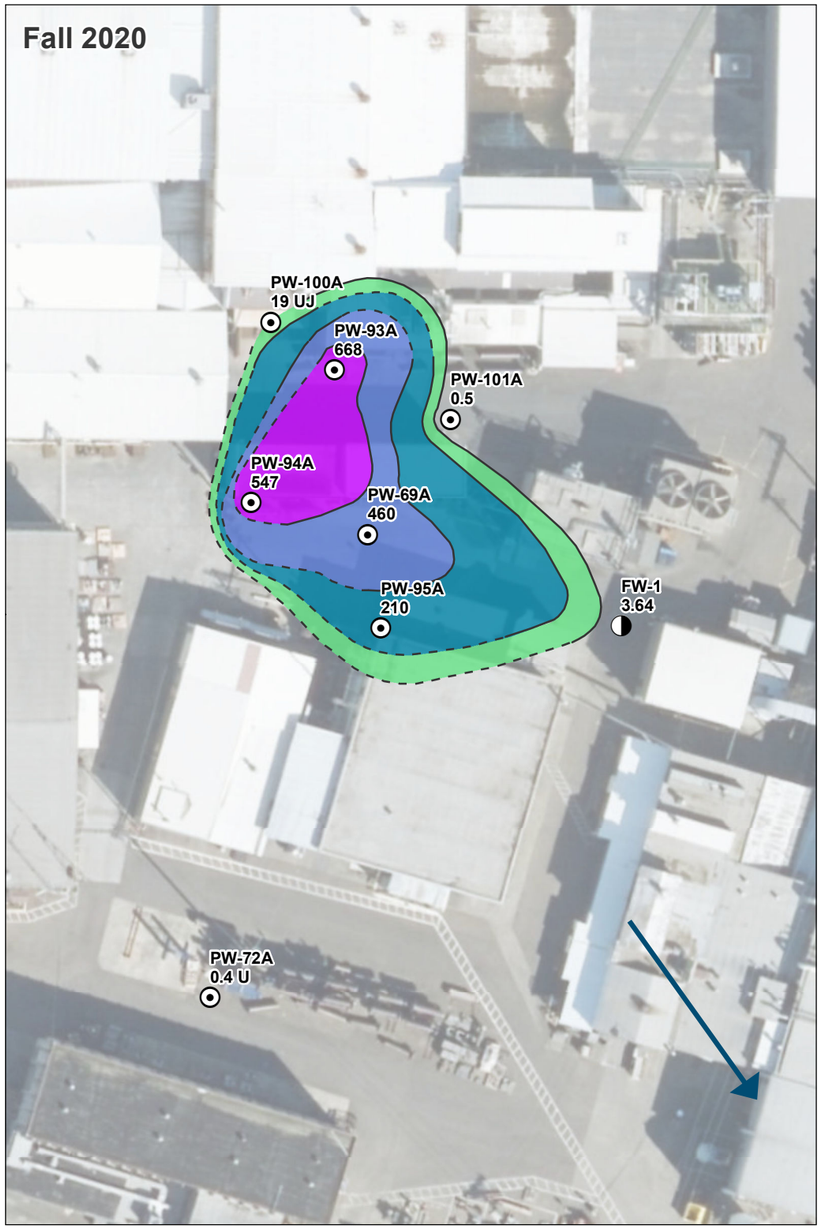






NOTES

1. Baseline 2010 1,1-DCA concentrations are from the spring 2010 monitoring event (May 2010), with the exception of FW-1 (September 2010), PW-101A (August 2010), and PW-100A (August 2010).
2. Baseline 2019 1,1-DCA concentrations are from the spring 2019 monitoring event (May 2019), with the exception of extraction well FW-1, which was sampled in August 2019.
3. Fall 2020 1,1-DCA concentrations are from the fall 2020 monitoring event (September 2020).
4. Cleanup level for 1,1-DCA is 3,700 µg/L.

1,1-DCA: 1,1-dichloroethane
µg/L: micrograms per liter
J: estimated value
NA: not available
U: not detected above reporting limit

Date: June 18, 2021
Data Sources: Linn Co., ESRI, Geoterra Inc. 2019

LEGEND

- Monitoring Well *1,1-DCA Concentration in µg/L*
- Extraction Well *1,1-DCA Concentration in µg/L*
- Groundwater Flow Direction
- 1,1-DCA Concentration Boundary (dashed where inferred)

1,1-DCA Concentrations (µg/L)

- 50 - 100
- 101 - 300
- 301 - 500
- 501 - 1,000
- 1,001 - 10,000
- > 10,000

FIGURE 9

1,1-DCA Isopleths for Baseline 2010, Baseline 2019, and Fall 2020

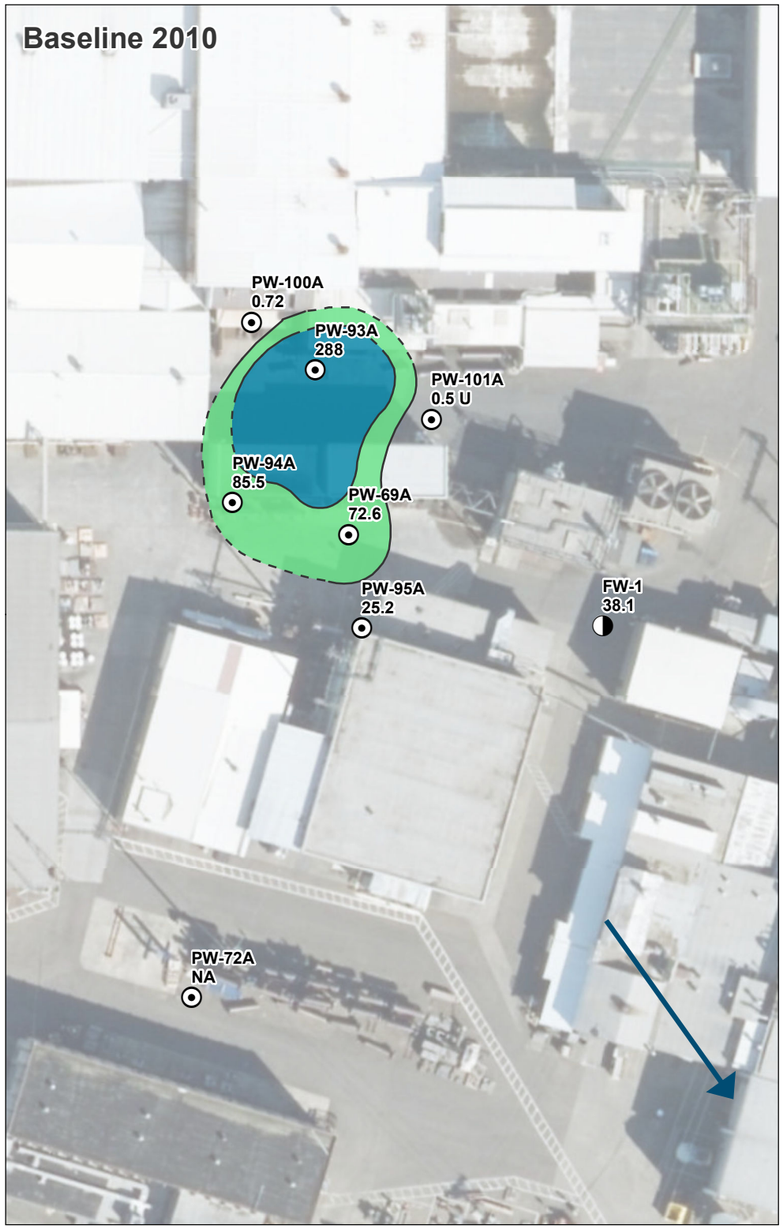
ATI Millersburg Operations, Oregon

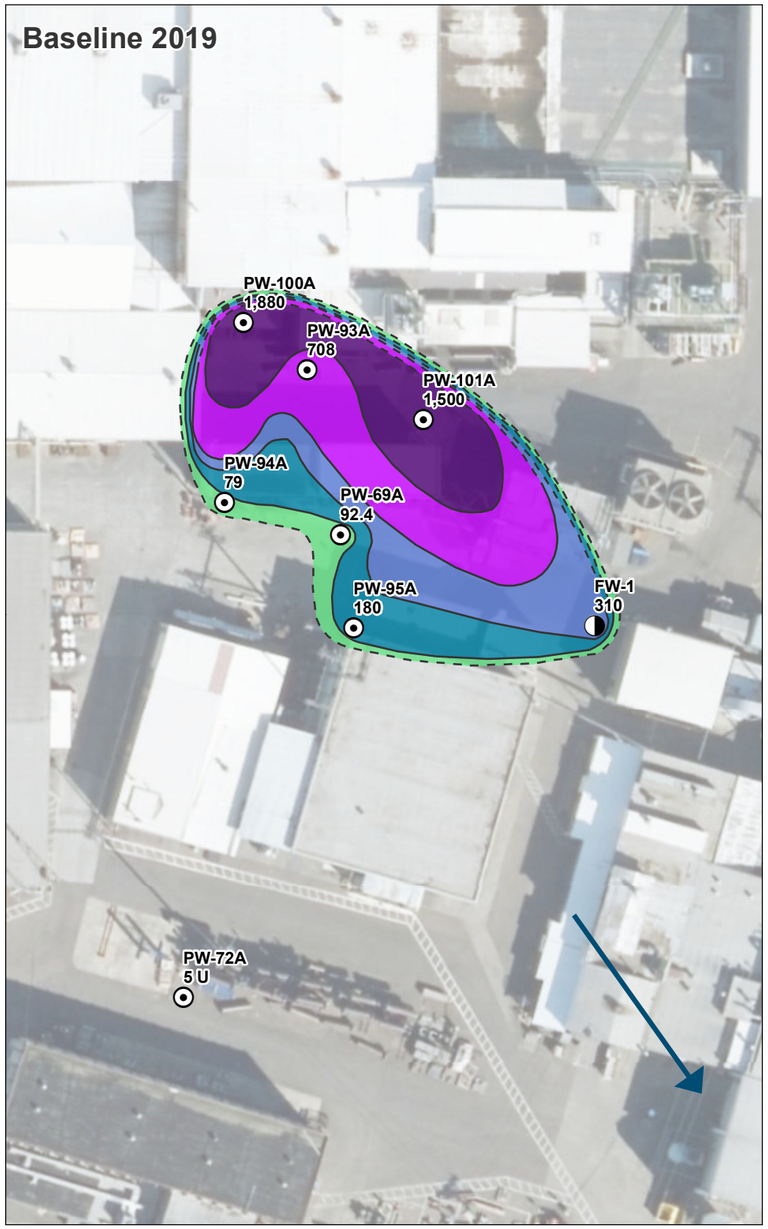
N

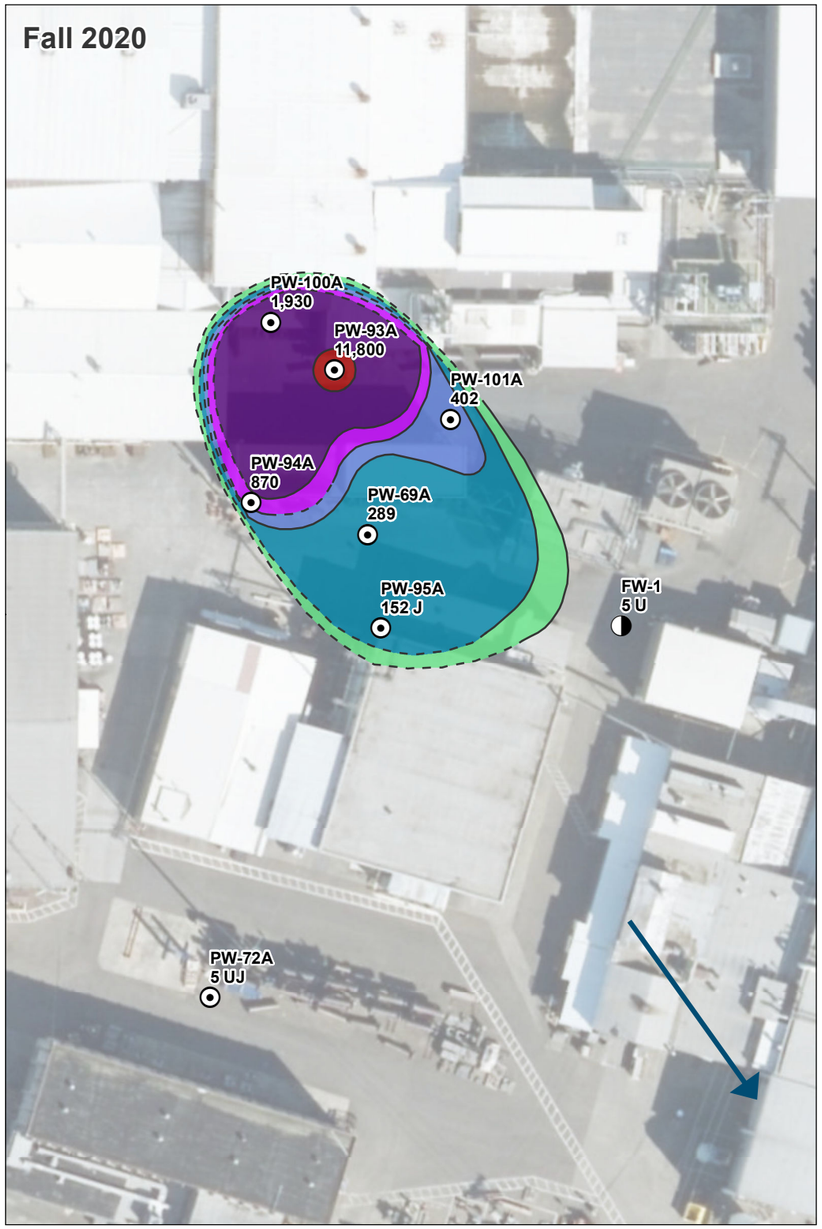
0 25 50 75
Feet

GSI Water Solutions, Inc.

Document Path: Y:\0168_Wah_Chang\Source_Figures\029_2020\FCCA_Remediation_Report\Figure9_DCA_Isopleths_Baseline_2010_2019_Fall_2020.mxd







NOTES

1. Baseline 2010 CA concentrations are from the spring 2010 monitoring event (May 2010), with the exception of FW-1 (September 2010), PW-101A (August 2010), and PW-100A (August 2010).
2. Baseline 2019 CA concentrations are from the spring 2019 monitoring event (May 2019), with the exception of extraction well FW-1, which was sampled in August 2019.
3. Fall 2020 concentrations are from the fall 2020 monitoring event (September 2020).
4. There is no cleanup level for CA.

CA: chloroethane
µg/L: micrograms per liter
J: estimated value
NA: not available
U: not detected above reporting limit

Date: June 14, 2021
Data Sources: Linn Co., ESRI, Geoterra Inc. 2019

LEGEND

- Monitoring Well
  CA Concentration in µg/L
- Extraction Well
  CA Concentration in µg/L
- Groundwater Flow Direction
- CA Concentration Boundary (dashed where inferred)

CA Concentrations (µg/L)

- 50 - 100
- 101 - 300
- 301 - 500
- 501 - 1,000
- 1,001 - 10,000
- > 10,000

FIGURE 10

CA Isopleths for Baseline 2010, Baseline 2019, and Fall 2020

ATI Millersburg Operations, Oregon

N

0 25 50 75
Feet

GSI Water Solutions, Inc.

Document Path: Y:\0168_Wah_Chang\Source_Figures\029_2020\FCCA_Remediation_Report\Figure10_CA_Isopleths_Baseline_2010_2019_Fall_2020.mxd

Appendices

APPENDIX A

Historical Performance Monitoring Results at FCCA Wells

Appendix A. Historical Performance Monitoring Results at FCCA Wells

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Parameter	Units	Cleanup Standard	Source Area Well PW-93A																
			Baseline 5/10	12/10	5/11	10/11	6/12	12/12	6/13	12/13	7/14	2/15	6/15	6/16	12/16	7/17	10/17	5/18	10/18
CVOCs																			
1,1,1- TCA	µg/L	200	**11,100**	**1,120**	**5,970**	**845**	**350**	19.6	16.7	11.5	10.1	28.2	28.7	18.8	26.6	46.6	29.1	76.7	29.3
1,1-DCA	µg/L	3,700	2,370	**9,770**	3,380	**6,218**	3,150 E	185	166	171	83.4	58	83.1	59.2	49.7	105	94	81.3	112
1,2-DCA	µg/L	5	25 U	10 U	25 U	10 U	4 U	2.5 U	2.5 U	0.5 U	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.4 U	4 U
Chloroethane	µg/L	--	288	263	659	182	6,310 E	1,200 E	1,865	310	243	89.5	175	100	94.9	260	336	446	2630
PCE	µg/L	5	**31.5**	**5.26** J	**14.3**	1.18 J	**19**	3.92	3.12	0.98	5 U	0.32 J	0.35 J	0.22 J	0.44 J	2.18	0.63	0.702	2.49 J
TCE	µg/L	5	**16.7** J	**29.4**	2.13 J	**17.4**	**31.3**	2.71	2.54	1.16	5 U	0.25 J	0.2 J	0.16 J	0.16 J	0.62	0.49 J	0.386 J	4 U
1,1-DCE	µg/L	7	**905**	**512**	**785**	**315**	**1,280**	**140**	**128**	**16.2**	**9.77**	**11.8**	**17.2**	**7.54**	6.71	**14.8**	**14.9**	**21.4**	**13.4**
cis-1,2-DCE	µg/L	70	31.9	**70.7**	26.2	34.4	**291**	19.1	17.2	1.29	5 U	0.33 J	0.32 J	0.3 J	0.22 J	0.63	0.53	0.302 J	3.46 J
trans-1,2-DCE	µg/L	100	25 U	10 U	25 U	10 U	4 U	2.5 U	2.5 U	0.5 U	5 U	0.5 U	0.5 U	--	--	--	--	--	--
VC	µg/L	2	**13.5** J	10 U	25 U	10 U	**88.4**	**41.4**	**38.3**	**7.43**	**5.07**	**2.49**	**4.1**	**2.51**	**2.52**	**3.45**	**5.51**	**2.88**	**16.8**
Dissolved Hydrocarbon Gases																			
Methane	µg/L	--	539	664	426	623	1,840	4,610	3,800	6480	NA	6,650	2160	NA	3,950	11,100	11,000	11,000	8,400
Ethane	µg/L	--	0.54 J	0.7 J	1.3	0.48 J	0.67	0.7 J	0.7 J	1.54 J	NA	5.9 U	0.127 J	NA	0.8 U	3.0 U	2.85 U	1 U	0.38
Ethene	µg/L	--	1.92	1.69 J	1.38	1.54 J	14.2	9.71	9.12	3.9	NA	2.01 J	0.776 J	NA	0.55 J	1.27 J	1.91 J	2.8	3.5
General Chemistry																			
Chloride	mg/L	--	57	61	62	68	75.4	24.7	27.2	25.5	NA	9.22	7.1	8.29	7.95	18.9	13.1	8.86	11
Nitrate	mg/L	10	5 U	5 U	5 U	5 U	0.02 U	0.1 U	0.1 U	0.007 U	NA	0.014 J	0.0038 J	0.1 U	0.037 U	0.1 U	0.1 U	0.25 U	0.25 U
Sulfate	mg/L	--	10 U	10 U	10 U	10 U	0.03 U	0.1 U	0.523	0.885	NA	0.1 U	0.198	0.5	0.18 J	0.18 J	0.13 J	1 U	1 U
Alkalinity	mg/L	--	128	256.0	418	516	699	378	315	231	NA	96.9	76.8	86.7	86.7	81.3	95.7	83	NA
Total Organic Carbon																			
Total Organic Carbon	mg/L	--	5	152	251	463	671	87.6	54.1	14.3	NA	7.49	7.21	4.28	4.14	NA	NA	NA	NA
Metals																			
Iron	mg/L	--	4	8	35	71	104	28	22	NA	NA	9	7.18	6.51	6	NA	NA	NA	NA
Sodium	mg/L	--	29	56	72	89	198	51.6	36.4	27.3	NA	13.6	11.8	10.8	10.1	NA	NA	NA	NA
Parameters																			
ORP	mV	--	28.7	-184.4	23.7	-233.4	-1.2	34.3	33.1	-72.4	28.3	-12.2	-71.2	43.7	-47.4	15.7	3.8	58.6	-20.6
Dissolved Oxygen	mg/L	--	0.86	0.22	0.21	0.21	0.2	0.13	0.22	0.24	0.11	0.3	0.18	0.12	0.14	0.11	0.07	0.13	0.76

Notes

-- = no applicable cleanup level
µg/L = micrograms per liter
CVOC = chlorinated volatile organic compound
DCA = dichloroethane
DCE = dichloroethene
EISB = enhanced in situ bioremediation
FCCA = Former Crucible Cleaning Area
J = estimated value below reporting limit
mg/L = milligrams per liter
mV = millivolts
NA = not analyzed
NS = not sampled
ORP = oxidation-reduction potential
PCE = tetrachloroethene
TCA = trichloroethane
TCE = trichloroethene
U = not detected above reporting limit
VC = vinyl chloride

Bold indicates that the concentration meets or exceeds the cleanup standard. Refer to Quality Assurance Project Plan for the Sitewide Remedial Action Table B-4 for more details (GSI, 2015).

Appendix A. Historical Performance Monitoring Results at FCCA Wells

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Parameter	Units	Cleanup Standard	Injection Area Well																
			PW-100A																
			Baseline 8/10	12/10	5/11	10/11	6/12	12/12	6/13	12/13	7/14	2/15	6/15	6/16	12/16	7/17	10/17	5/18	10/18
CVOCs																			
1,1,1- TCA	µg/L	200	0.99	113	102	84.5	35.3	0.95	0.81	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**1,060**	**1,080**	**436**	0.823
1,1-DCA	µg/L	3,700	5.5	2250	2100	1850	222 E	10.7	10.2	2.78	3.18	2.54	2.2	0.99	1.06	1680	2040	1970	56.7
1,2-DCA	µg/L	5	0.5 U	2.5 U	2.5 U	2.5 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.4 U	0.4 U
Chloroethane	µg/L	--	0.72	190	178	164	653 E	0.66	0.56	21.1	10.4	4.31	11.5	3.08	3.65	752	1290	4790	2510
PCE	µg/L	5	**7.23**	2.99	2.46	1.45	4.14	0.49 J	0.41 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	**6.77**	**9.4**	**10.1**	0.982
TCE	µg/L	5	**43**	**5.37**	**5.11**	4.81	2.96	0.37 J	0.33 J	0.3	0.5 U	0.5 U	0.5 U	0.73	0.5 U	**8.61**	**10.9**	**8.54**	1.39
1,1-DCE	µg/L	7	6.09	**103**	**99.9**	**81.4**	**43.6**	1.85	1.78	0.45 J	0.37 J	0.31 J	0.5 U	0.5 U	0.5 U	**77.3**	**128**	**168**	2.4
cis-1,2-DCE	µg/L	70	**83.4**	57.2	53.1	43.4	8.88	1.22	1.18	1.28	4.92	0.62	0.21 J	12.9	3.27	6.84	9.65	13.7	36.8
trans-1,2-DCE	µg/L	100	12.2	2.5 U	2.5 U	2.5 U	6.31	3.2	3.01	7.84	7.14	6.96	5.83	--	--	--	--	--	--
VC	µg/L	2	**5.18**	**19.9**	**16.8**	**7.64**	**6.44**	1.05	1.04	**2.03**	**4.12**	0.97	0.67	**14.2**	**4.43**	**14**	**21.2**	**37**	**30.5**
Dissolved Hydrocarbon Gases																			
Methane	µg/L	--	31.5	625	586	515	2,640	2,555	2410	6,920	NA	7,860	1,620	NA	3540	14,000	13,200	2.4	13,000
Ethane	µg/L	--	0.15 J	1.1 J	1.1 J	1.09 J	0.4 J	0.5 J	0.41 J	0.8 J	NA	2.73 J	1.1	NA	3.95	6.7	4.9	15	4.2
Ethene	µg/L	--	0.76 J	5.98	3.54	1.18 J	5.96	5.64	5.65	3.18	NA	2.72 J	0.391 U	NA	7.12	9.86	11.7	12000	37
General Chemistry																			
Chloride	mg/L	--	12	42	38	26	17.8	15	14	13.9	NA	12.3	14.3	12.9	12.5	23.4	21.5	20.1	19.4
Nitrate	mg/L	10	5 U	5 U	5 U	5 U	0.02 U	0.1 U	0.1 U	0.007 U	NA	0.033 J	0.029 J	0.100 U	0.1 U	0.100 U	0.100 U	0.25 U	0.25 U
Sulfate	mg/L	--	10 U	10 U	10 U	10 U	0.03 U	0.1 U	0.1 U	0.034 U	NA	0.883	0.50	2.95	1.36	0.20	0.16 J	1 U	1 U
Alkalinity	mg/L	--	112	253.0	282	411	502.0	444	434	255.0	NA	221	228.0	187	178	168.0	188	181	176
Total Organic Carbon																			
Total Organic Carbon	mg/L	--	13	48	156	222	412	87.3	46.1	4.42	NA	2.39	2.28	1.75	1.85	NA	NA	NA	NA
Metals																			
Iron	mg/L	--	3.21	11.2	28	33	51.9	24.2	22.9	16	NA	16.1	15.6	11.4	9.79	NA	NA	NA	NA
Sodium	mg/L	--	11.6	35	44	69	120	67.3	61.2	33.9	NA	31	34.4	30.5	23.7	NA	NA	NA	NA
Parameters																			
ORP	mV	--	33.1	12.5	9.8	11.2	-0.2	NA	-72.8	-71.1	-49.8	-162.5	-54.1	-32.1	-138.6	-26.1	-54.6	-23.3	-56.2
Dissolved Oxygen	mg/L	--	0.64	0.35	0.35	0.35	0.21	NA	0.65	0.55	0.87	0.18	0.22	0.12	0.13	0.11	0.07	0.05	0.66

Appendix A. Historical Performance Monitoring Results at FCCA Wells

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Parameter	Units	Cleanup Standard	Injection Area Well PW-94A																
			Baseline 5/10	12/10	5/11	10/11	6/12	12/12	6/13	12/13	7/14	2/15	6/15	6/16	12/16	7/17	10/17	5/18	10/18
CVOCs																			
1,1,1- TCA	µg/L	200	39	197	12	156	129 E	153 E	146	**260**	**1,380**	**1,610**	**1,830**	**2,460**	**2,260**	**1,430**	**1,190**	**1,630**	**525**
1,1-DCA	µg/L	3,700	25.7	125	8.96	81	43.3	60.1	58.2	75.4	118	121	166	187	130	599	522	358	469
1,2-DCA	µg/L	5	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	25 U	25 U	2.5 U	5 U	5 U	2.5 U	2.5 U	4 U	2 U
Chloroethane	µg/L	--	85.5	95.9	36.1	72.8	34.2	35.8	32.5	49.5	41	39.5	71.9	84.6	50.1	134	166	235	151
PCE	µg/L	5	0.5 U	0.1 J	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	1.16	25 U	25 U	1.31 J	**5.7**	1.66 J	2.29 J	2.2 J	4 U	2.24
TCE	µg/L	5	0.31 J	0.23 J	0.5 U	0.5 U	0.26 J	0.28 J	0.5 U	2.88	25 U	25 U	1.58 J	4.29 J	2.72 J	2.56	3.06	4 U	2.49
1,1-DCE	µg/L	7	1.9	**11.1**	0.23 J	**8.12**	4.04	5.16	4.99	**10.1**	**71**	**97.3**	**90.8**	**116**	**110**	**122**	**122**	**154**	**138**
cis-1,2-DCE	µg/L	70	1.2	0.83	0.76	0.84	0.48 J	0.53	0.5 U	3.86	25 U	25 U	2.19 J	5.34	3.28 J	5.62	4.62	4 U	2.08
trans-1,2-DCE	µg/L	100	0.5 U	0.5 U	0.5 U	0.5 U	0.2 U	0.5 U	0.5 U	0.5 U	25 U	25 U	2.5 U	--	--	--	--	--	--
VC	µg/L	2	1.7	1.39	0.68	0.81	0.67	0.76	0.71	**2.24**	25 U	25 U	**2.23** J	1.93 J	**2.54** J	**11.4**	**4.91**	**11.6**	**4.78**
Dissolved Hydrocarbon Gases																			
Methane	µg/L	--	NA	1,120	1,080	890	612	779	840	1,050	NA	1,200	774	NA	1,300	1,980	1,900	3,100	1 U
Ethane	µg/L	--	NA	0.7 J	0.3 J	0.18 J	0.17 J	0.13 J	0.32	0.495	NA	0.285 J	0.2 J	NA	0.26	0.6	0.61	1.4	1 U
Ethene	µg/L	--	NA	0.32 J	0.51 J	0.51 J	0.25 J	0.67	0.78	1.08	NA	1.04	0.38 J	NA	0.85	3.01	1.19	3.3	1 U
General Chemistry																			
Chloride	mg/L	--	13	15	16	20	21.3	13.4	12.2	11.6	NA	10.9	9.31	11.3	9.82	33.3	29.8	21.8	14.6
Nitrate	mg/L	10	5 U	5 U	5 U	5 U	0.02 U	0.1 U	0.1 U	0.007 U	NA	0.004 J	0.100 U	0.100 U	0.1 U	0.1 U	0.1 U	0.25 U	0.25 U
Sulfate	mg/L	--	10 U	10 U	10 U	10 U	0.25	0.38	2.13	3.86	NA	1.21	0.43	1.40	2.11	1.1	1.25	1.47	1 U
Alkalinity	mg/L	--	174	215	193	164	67.6	89.5	128	109	NA	94.7	82.2	102	109	113	123	98.1	89
Total Organic Carbon																			
Total Organic Carbon	mg/L	--	5 U	18	11.3	6.14	2.21	2.32	2.12	1.95	NA	2.11	2.46	2	2.04	NA	NA	NA	NA
Metals																			
Iron	mg/L	--	5.4	5.3	5.5	5.4	5.47	5.35	5.66	5.71	NA	6.66	6	5.34	6.59	NA	NA	NA	NA
Sodium	mg/L	--	32	41	28	19	14.4	14.9	15.3	16.7	NA	14.2	14.2	15.9	16.3	NA	NA	NA	NA
Parameters																			
ORP	mV	--	-66.2	-148.2	-72.2	-190.2	-72.3	-76.3	-78.1	39.7	21.9	-171.6	-100.1	-68.6	-99.1	-78.6	-82.3	-10	-70
Dissolved Oxygen	mg/L	--	0.36	0.33	0.3	0.26	0.22	0.25	0.32	1.1	0.32	0.17	0.2	0.12	0.12	0.17	0.09	0.06	0.76

Appendix A. Historical Performance Monitoring Results at FCCA Wells

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Parameter	Units	Cleanup Standard	Near Injection Area Well																
			PW-69A																
			Baseline 5/10	12/10	5/11	10/11	6/12	12/12	6/13	12/13	7/14	2/15	6/15	6/16	12/16	7/17	10/17	5/18	10/18
CVOCs																			
1,1,1- TCA	µg/L	200	**368**	28.8	**245**	13.4	43.4	127 E	111	145	9.5	103	95.4	60.5	55.4	96.2	117	**281**	102
1,1-DCA	µg/L	3,700	246	141	189	135	56.8	100	97.3	149	11.3	38.3	38	31.5	38.3	84.7	112	143	28.5
1,2-DCA	µg/L	5	5 U	0.5 U	5 U	0.5 U	2 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.4 U	4 U
Chloroethane	µg/L	--	72.6	510	89.1	348	85.8	95.3	76.2	119	6.6	28.3	28.4	19.4	30.2	67.3	86.8	302	54.4
PCE	µg/L	5	**8.21**	**6.69**	**7.12**	4.26	0.5 U	**8.55**	**7.68**	**5.06**	0.48 J	4 J	3.61	2.13	2.77	**7.47**	**6.48**	**10.8**	2.07 J
TCE	µg/L	5	**5.3**	4.23	3.96	1.96	2 U	1.37	1.26	1.04	0.18 J	5 U	0.43 J	0.24 J	0.31 J	0.82	0.73	2 U	4 U
1,1-DCE	µg/L	7	**31.2**	**44.3**	**28.4**	**28.6**	5.92	**9.73**	**8.21**	**13.2**	1.25	**10.4**	**8.48**	6.28	5.21	**14.5**	**17.4**	**30.9**	**8.08**
cis-1,2-DCE	µg/L	70	5.2 J	16.6	5.2	12.2	2.9 J	4.16	2.11	4.72	1.44	6.07	5.05	2.97	4.19	12.5	10	10.3	4 U
trans-1,2-DCE	µg/L	100	5 U	0.5 U	5 U	0.5 U	2.9 U	0.5 U	0.5 U	0.5 U	0.5 U	5 U	0.5 U	--	--	--	--	--	--
VC	µg/L	2	**4.8** J	1.06	**3.8** J	0.43 J	2 U	**2.06**	1.88	**3.19**	0.28 J	1.77 J	1.42	1.03	1	1.75	**2.26**	**5.14**	4 U
Dissolved Hydrocarbon Gases																			
Methane	µg/L	--	890	1,170	1,310	1,080	2.8	3,190	2,850	1,030	NA	1,140	994	NA	892	1,680	1,760	3,400	3,100
Ethane	µg/L	--	0.12 J	0.13 J	0.12 J	0.12 J	0.22 J	0.56 J	0.33 J	0.227 J	NA	0.173 J	0.15 J	NA	0.15 J	0.28 J	0.34	1 U	1 U
Ethene	µg/L	--	0.13 J	0.14 J	0.13 J	0.13 J	0.3 J	0.48 J	0.43	0.417	NA	0.779	0.525	NA	0.2 J	0.38	0.41	1.6	1 U
General Chemistry																			
Chloride	mg/L	--	12	18	21	25	28.3	5.86	21.5	18.6	NA	14.3	12.1	11.3	28.4	26.9	21.3	19.8	9.16
Nitrate	mg/L	10	5 U	5 U	5 U	5 U	0.02 U	0.1 U	0.1 U	0.007 U	NA	0.007 J	0.1 U	0.09 U	0.1 U	0.1 U	0.1 U	0.25 U	0.25 U
Sulfate	mg/L	--	10 U	10 U	10 U	10 U	0.11	0.032 J	0.31	0.607	NA	0.2	0.383	0.58	0.47	0.43	0.42	1 U	1 U
Alkalinity	mg/L	--	14	52	101	189	214	158	158	138	NA	96.7	86.7	89.8	93.5	109	119	117	84.3
Total Organic Carbon																			
Total Organic Carbon	mg/L	--	5 U	34	18	13	4.69	4.15	4.78	4.69	NA	3.05	3.09	2.69	2.76	NA	NA	NA	NA
Metals																			
Iron	mg/L	--	0.65	2.9	5.8	7.1	13.2	9.36	8.81	8.59	NA	6.43	6.08	4.75	3.16	NA	NA	NA	NA
Sodium	mg/L	--	12.5	18	22	27	30.4	24.9	22.8	21.4	NA	17.7	17.9	17.5	10.6	NA	NA	NA	NA
Parameters																			
ORP	mV	--	-98.5	-48.3	-117.5	-51.3	-118.5	-125.5	-127.7	37.1	118.6	39.5	-91.2	-59.4	-73.1	-61	-65.3	-53.1	-74.5
Dissolved Oxygen	mg/L	--	0.29	0.25	0.28	0.18	0.28	0.29	0.36	0.59	0.1	0.25	0.34	0.1	0.1	0.1	0.09	0.04	1.03

Appendix A. Historical Performance Monitoring Results at FCCA Wells

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Parameter	Units	Cleanup Standard	Near Injection Area Well																
			PW-95A																
			Baseline 5/10	12/10	5/11	10/11	6/12	12/12	6/13	12/13	7/14	2/15	6/15	6/16	12/16	7/17	10/17	5/18	10/18
CVOCs																			
1,1,1- TCA	µg/L	200	**348**	90.4	**234**	45.2	8.98	175 E	156	132	65.2	**582**	**259**	**373**	149	**699**	153	26	**363**
1,1-DCA	µg/L	3,700	152	60.6	3.16	45.1	32.6	43.9	41.6	50.2	40.3	79.8	45.8	63.7	36.4	799	275	66.1	155
1,2-DCA	µg/L	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	25 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.4 U	0.4 U
Chloroethane	µg/L	--	25.2	9.11	21.3	7.86	8.12	16.4	15.3	35.8	44.8	25 U	5.02	11.3	6.3	128	35.6	12.3	69
PCE	µg/L	5	1.51	1.12	0.65	0.78	0.5 U	1.67	1.25	1.22	3.27	25 U	0.68	1.06	0.65	2.11	0.84	0.257 J	0.639
TCE	µg/L	5	2.3	0.68	1.9	0.23 J	0.5 U	0.46 J	0.5 U	1.43	0.51	25 U	0.65	0.86	0.58	2.84	1.12	0.32 J	0.638
1,1-DCE	µg/L	7	**15.2**	**15.5**	**8.18**	**12.3**	**7.11**	**9.56**	**9.21**	**10.5**	4.55	**43.9**	**19.9**	**28.8**	**14.1**	**104**	**49.5**	**12.2**	**39.3**
cis-1,2-DCE	µg/L	70	4.2	0.43 J	2.74	0.5 U	0.5 U	1.49	1.34	5.15	4.08	25 U	2.05	2.71	1.75	9.98	3.33	0.738	1.54
trans-1,2-DCE	µg/L	100	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	25 U	0.5 U	--	--	--	--	--	--
VC	µg/L	2	**3.8**	0.24 J	**2.1**	0.5 U	0.5 U	0.84	0.76	**3.16**	1.43	25 U	1.04	1.41	0.95	0.76	0.38 J	0.235 J	**2.62**
Dissolved Hydrocarbon Gases																			
Methane	µg/L	--	-	77.3	58.2	64.2	498	250	348	514	NA	204	154	NA	433	1,420	970	490	900
Ethane	µg/L	--	-	0.11 U	0.09 U	0.11 U	0.068 U	0.35 U	0.21 J	0.147 J	NA	0.356 U	0.373 U	NA	0.24 U	0.53 U	0.31 U	1 U	1 U
Ethene	µg/L	--	-	0.095 U	0.096 U	0.095 U	0.5 J	0.25 J	0.89	1.74	NA	0.429	0.157 J	NA	0.2 J	0.98	0.43	1 U	1.7
General Chemistry																			
Chloride	mg/L	--	17	20	42	58	69.8	39.8	35.8	23.7	NA	22	26	29	20	21.4	20	16.6	18.5
Nitrate	mg/L	10	5 U	5 U	5 U	5 U	0.33	0.18	0.1 U	0.007 U	NA	0.487	0.588	0.29 U	0.33	0.57	0.57	1.13	0.25 U
Sulfate	mg/L	--	10 U	10 U	10 U	10 U	1.82	1.64	2.11	2.49	NA	3.5	2.71	2.76 J	3.17	4.11	4.23	4.76	4.27
Alkalinity	mg/L	--	46	54	68	109	NA	131	123	131	NA	129	128	140	138	88.3	89.4	74	96.6
Total Organic Carbon																			
Total Organic Carbon	mg/L	--	5 U	7.2	5.46	3.25	1.81	1.53	1.64	1.52	NA	1.83	2.35	2.47	2.63	NA	NA	NA	NA
Metals																			
Iron	mg/L	--	0.75	0.58	0.34	0.48	0.367	0.256	1.2	1.6	NA	1.3	0.31	1.82	0.363	NA	NA	NA	NA
Sodium	mg/L	--	20	26	36	41	58.4	46.1	8.94	3.69	NA	3.7	42.9	48.2	46.5	NA	NA	NA	NA
Parameters																			
ORP	mV	--	-91.2	-124.4	-84.2	-129.4	-81.3	-79.3	-81.06	36	-22.5	-154.5	57.7	44.4	-12.4	46.5	50.7	50.6	102.9
Dissolved Oxygen	mg/L	--	0.15	0.16	0.13	0.13	0.11	0.01	0.1	0.77	0.18	0.17	0.42	0.41	0.25	0.25	0.17	0.06	1.1

Appendix A. Historical Performance Monitoring Results at FCCA Wells

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Parameter	Units	Cleanup Standard	Near Injection Area Well																
			PW-101A																
			Baseline 8/10	12/10	5/11	10/11	6/12	12/12	6/13	12/13	7/14	2/15	6/15	6/16	12/16	7/17	10/17	5/18	10/18
CVOCs																			
1,1,1- TCA	µg/L	200	0.08 J	8.93	6.78	5.67	0.3 J	0.5 U	0.5 U	1.25	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.4 U	0.408
1,1-DCA	µg/L	3,700	1.56	671	591	513	2.99	0.95	0.87	0.75	0.42 J	0.51	1.85	0.51	0.67	2.85	2.89 J	13.7	6.03
1,2-DCA	µg/L	5	0.5 U	1.1 U	1.1 U	1.1 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.4 U	0.4 U
Chloroethane	µg/L	--	0.5 U	163	161	142	1.24	0.25 J	0.5 U	0.82	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	23.7	71.3 J	1340	20.3
PCE	µg/L	5	0.5 U	**5.28**	3.89	4.18	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.4 U	0.4 U
TCE	µg/L	5	0.12 J	4.02	3.89	1.84	0.32 J	0.61	0.59	0.5 U	0.17 J	0.5 U	0.44 J	0.28 J	0.71	0.74	0.43 J	0.526	0.458
1,1-DCE	µg/L	7	0.16 J	**286**	**183**	**64.8**	0.33 J	0.5 U	0.5 U	0.5 U	0.35 J	0.5 U	0.5 U	0.5 U	0.5 U	0.17 J	0.16 J	1.66	0.615
cis-1,2-DCE	µg/L	70	0.19 J	25.4	20.1	15.7	0.65	0.32 J	0.5 U	0.5 U	0.29 J	0.32 J	1.57	0.62	1.08	0.87	0.46 J	0.738	0.607
trans-1,2-DCE	µg/L	100	0.5 U	0.2 J	0.5 U	1.1 U	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	--	--	--	--	--	--
VC	µg/L	2	0.5 U	**36.5**	**31.2**	**26.4**	0.2 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.26 J	0.52 J	1.83	0.4 U
Dissolved Hydrocarbon Gases																			
Methane	µg/L	--	23.6	258	268	218	263	48	46.2	167	NA	121	59.8	NA	230	NA	NA	NA	NA
Ethane	µg/L	--	0.079 J	0.4 J	0.38 J	0.46 J	0.08 U	0.52 U	0.5 U	0.042 J	NA	0.304 U	0.369 U	NA	0.21 U	NA	NA	NA	NA
Ethene	µg/L	--	0.05 U	3.32	3.11	2.98	0.079 U	0.55 U	0.53 U	0.236 J	NA	0.081 J	0.404 U	NA	0.23 U	NA	NA	NA	NA
General Chemistry																			
Chloride	mg/L	--	21	11	15	18	20.9	18.2	17.1	13.6	NA	7.84	7.34	5.47	18.6	NA	NA	NA	NA
Nitrate	mg/L	10	5 U	5 U	5 U	5 U	0.02 U	0.1 U	0.1 U	0.142	NA	0.012 J	0.1 U	0.1 U	0.1 U	NA	NA	NA	NA
Sulfate	mg/L	--	10 U	10 U	10 U	10 U	4.33	6.35	6.19	5.71	NA	3.89	3.84	3.61	5.23	NA	NA	NA	NA
Alkalinity	mg/L	--	11	16	34	59	67	57.1	56.2	51.7	NA	47.4	45.8	41.9	44.7	NA	NA	NA	NA
Total Organic Carbon																			
Total Organic Carbon	mg/L	--	1.08	2.34	5.69	4.65	3.25	3.22	3.1	1.6	NA	1.66	1.79	1.29	1.39	NA	NA	NA	NA
Metals																			
Iron	mg/L	--	0.37	0.65	0.78	0.91	1.41	0.964	0.92	0.225	NA	0.184	0.163 J	0.123	0.426	NA	NA	NA	NA
Sodium	mg/L	--	12.3	11.6	13.2	12.9	14	12.8	11.1	11.2	NA	9.61	10.4	8.99	10.4	NA	NA	NA	NA
Parameters																			
ORP	mV	--	48.2	64.5	52.3	75.5	NA	NA	12.68	13	110.7	-77	70.9	37.4	7.6	46.8	33.5	44.3	16.5
Dissolved Oxygen	mg/L	--	0.48	0.61	0.45	0.46	NA	NA	0.29	0.2	0.1	0.37	0.37	0.13	0.11	0.19	0.22	0.06	0.42

Appendix A. Historical Performance Monitoring Results at FCCA Wells

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Parameter	Units	Cleanup Standard	Perimeter Area Well																
			FW-1																
			Baseline 9/10	12/10	5/11	10/11	6/12	12/12	6/13	12/13	7/14	2/15	6/15	6/16	12/16	7/17	10/17	5/18	10/18
CVOCs																			
1,1,1- TCA	µg/L	200	**1,922**	**1,789**	**1,403**	**1,089**	**379**	**494**	113.2	88.2	186	**257**	**234**	**298**	174	67.1	71.7	NS	**445**
1,1-DCA	µg/L	3,700	366	351	174	148	456	111	55.1	48.3	316	359	364	440	256	0.5 U	0.5 U	NS	119
1,2-DCA	µg/L	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	25 U	25 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NS	4 U
Chloroethane	µg/L	--	38.1	39.2	55.1	42.6	49.8	28.4	20.4	11.3	880	556	519	494	212	306	407	NS	191
PCE	µg/L	5	1.89	1.29	0.53	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	25 U	25 U	0.92	1.14	0.82	0.5 U	0.5 U	NS	4 U
TCE	µg/L	5	3.58	3.01	0.35 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	25 U	25 U	1.6	1.83	1.98	0.5 U	0.5 U	NS	4 U
1,1-DCE	µg/L	7	**239**	**216**	**168**	**108**	**187**	**76.1**	**49.3**	**45.8**	**70.9**	**85.6**	**71.3**	**81.4**	**47.1**	**88.2**	**103**	NS	**41.9**
cis-1,2-DCE	µg/L	70	9.86	8.77	8.51	6.75	2.55	6.75	5.12	3.36	25 U	25 U	4.59	5.43	3.91	2.64	3.2	NS	2.62 J
trans-1,2-DCE	µg/L	100	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	25 U	25 U	0.5 U	--	--	0.5 U	0.5 U	NS	--
VC	µg/L	2	**5.89**	**4.76**	**2.53**	**2.67**	**3.94**	1.54	**2.59**	1.32	**17.3** J	25 U	**13**	**11**	**6.12**	**5.39**	**4.1**	NS	**6.03**
Dissolved Hydrocarbon Gases																			
Methane	µg/L	--																	
Ethane	µg/L	--																	
Ethene	µg/L	--																	
General Chemistry																			
Chloride	mg/L	--																	
Nitrate	mg/L	10																	
Sulfate	mg/L	--																	
Alkalinity	mg/L	--																	
Total Organic Carbon																			
Total Organic Carbon	mg/L	--																	
Metals																			
Iron	mg/L	--																	
Sodium	mg/L	--																	
Parameters																			
ORP	mV	--																	
Dissolved Oxygen	mg/L	--																	

APPENDIX B

Supplemental Field Observations from String 3 Injection Activities

Appendix B-1. Makeup Water Analytical Results, August 15, 2019

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

	Chlorinated Volatile Organic Compounds (µg/L)									
Sample	TCA	1,1-DCA	1,2-DCA	CA	PCE	TCE	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	VC
ATI-MUTank-8-19	149	184	0.80 U	90.3	0.474 J	0.984	20.7	2.66	0.80 U	1.79

Notes
µg/L = microgram per liter
CA = chloroethane
DCA = 1,1-dichloroethane
DCE = 1,1-dichloroethene
J = estimated value
PCE = tetrachloroethene
TCA = 1,1,1-trichloroethane
TCE = trichloroethene
U = not detected above reporting limit
VC = vinyl chloride

Appendix B-2. FCCA Monitoring Well Water Level Summary during String 3 EISB Injection

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Date	August 23, 2019			August 24, 2019						August 25, 2019		
Time	11:34	19:30 Start of Injections	20:05	0:10	4:10	8:15	12:00	16:00	20:00	0:00	3:10 End of Injections	13:00
Well	Depth to Groundwater (feet below top of casing)											
Source Area Well												
PW-93A	9.07		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		8.41
Injection Area Wells												
PW-94A	9.47		6.02	5.40	5.05	5.02	5.11	5.30	5.60	5.40		8.99
PW-100A	8.80		3.12	2.33	2.22	2.47	3.00	2.85	2.98	3.29		8.30
Near Injection Area Wells												
PW-69A	8.06		6.43	5.81	5.60	5.41	5.35	5.30	5.31	5.33		7.10
PW-95A	12.23		9.88	6.08	8.83	9.42	8.73	8.90	9.08	8.99		NM
PW-101A	11.02		4.32	3.47	3.56	2.98	2.84	4.00	4.69	4.21		10.47

Notes
EISB = enhanced in situ bioremediation
FCCA = Former Crucible Cleaning Area
NM = not measured

Appendix B-3. Substrate Solution Distribution Monitoring Summary during String 3 EISB Injection

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Date	August 23, 2019			August 24, 2019									August 25, 2019		
Time	19:30	20:30	22:30	0:30	2:30	4:30	6:10	8:10	12:00	16:00	18:00	20:00	0:00	2:00	3:10
Location	Substrate Solution Observed (Y or N)														
Source Area Well															
PW-93A	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Injection Area Wells															
PW-94A	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
PW-100A	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Near Injection Area Wells															
PW-69A	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
PW-95A	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y
PW-101A	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes
EISB = enhanced in situ bioremediation
FCCA = Former Crucible Cleaning Area
N = No
Y = Yes

Appendix B-4. FCCA Performance Monitoring Sampling – Groundwater Field Parameters

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Well	Date[1]	Temperature (°C)	pH (unit)	Oxidation-Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm)	Total Organic Carbon (mg/L)
EPA Screening Criteria for Natural Anaerobic Biodegradation[2]		> 20	5 - 9	< 50 (possible) < -100 (likely)	< 0.5	--	> 20
SiREM Recommended Parameters		--	6.0 - 8.5	< -75	< 0.2	--	--
Source Area Well							
PW-93A	May-19	14.82	6.06	-2.6	0.27	225	NA
	October-19	18.34	5.87	-30.0	0.08	1,381	461
	April-20	15.72	6.16	-49.5	0.10	1,047	154
	September-20	18.77	6.00	-8.8	0.32	309	20.3
	December-20	15.60	6.34	-85.9	0.14	256	11.5
Injection Area Wells							
PW-94A	May-19	14.87	6.74	-101.3	1.08	337	NA
	October-19	18.95	6.69	-99.5	0.07	437	82.2
	April-20	15.60	6.79	-123.6	0.12	320	6.67
	July-20	17.81	6.58	-46.0	0.35	346	NA
	September-20	18.84	6.78	-82.2	0.47	334	5.13
	December-20	17.51	7.14	-136.7	0.32	297	NA
PW-100A	May-19	15.91	6.34	-34.2	0.23	347	NA
	October-19	17.68	6.33	-71.9	0.08	1,640	369
	April-20	17.17	6.36	-93.0	0.24	1,605	29
	September-20	17.45	6.64	-88.9	0.37	1,358	42.7
Near Injection Area Wells							
PW-69A	May-19	15.09	6.65	-72.7	0.53	291	NA
	October-19	19.10	6.91	-99.4	0.08	274	15
	April-20	15.57	6.53	-72.0	0.18	323	20
	September-20	19.14	6.72	-83.4	0.42	292	4

Appendix B-4. FCCA Performance Monitoring Sampling – Groundwater Field Parameters

Former Crucible Cleaning Area Enhanced In Situ Bioremediation String 3 Injection and Performance Summary
ATI Millersburg Operations, Oregon

Well	Date[1]	Temperature (°C)	pH (unit)	Oxidation-Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Specific Conductance (µS/cm)	Total Organic Carbon (mg/L)
EPA Screening Criteria for Natural Anaerobic Biodegradation[2]		> 20	5 - 9	< 50 (possible) < -100 (likely)	< 0.5	--	> 20
SiREM Recommended Parameters		--	6.0 - 8.5	< -75	< 0.2	--	--
PW-95A	May-19	15.67	6.65	28.1	0.26	272	NA
	October-19	17.99	7.19	-118.5	0.06	287	4.17
	April-20	15.98	6.82	-5.5	0.12	248	1.6
	September-20	18.12	6.60	4.6	0.39	250	1.7
PW-101A	May-19	15.45	6.49	26.6	0.37	236	NA
	October-19	17.30	6.60	-54.7	0.14	1,209	NA
	September-20	18.51	6.60	-62.9	0.35	790	NA

Notes

[1] Injections occurred in August 2019. Values from May 2019 represent baseline conditions, values from October 2019 represent post injection conditions.

[2] EPA screening criterion shown are for monitored natural attenuation processes (not enhanced in situ bioremediation), from EPA's 1998 Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, EPA/600/R-98/128.

-- = no applicable screening level
°C = degrees Celsius
µS/cm = microSiemens per centimeter
EPA = U.S. Environmental Protection Agency
mg/L = milligrams per liter
mV = millivolts
NA = not analyzed